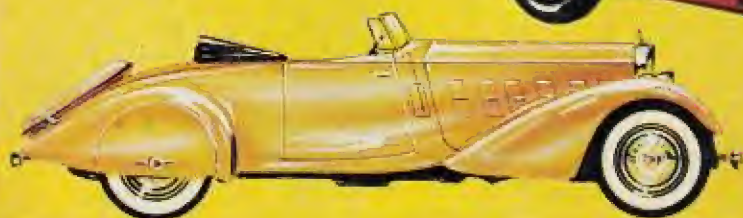


The
**HOW
AND
WHY**
Wonder Book of

45p

THE MOTOR CAR





THE HOW AND WHY WONDER BOOK OF **MOTOR-CARS**

Written by NICK GEORGANO
Illustrated by GORDON DAVIES

TRANSWORLD PUBLISHERS • LONDON

1903 MERCEDES



CITROEN



FORD. DESIGN STUDY.

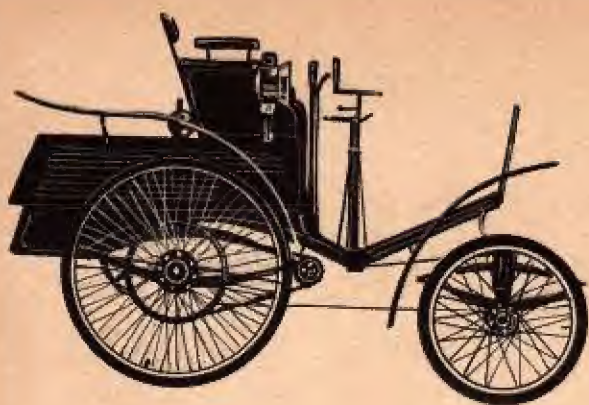


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AUSTIN SWALLOW





INTRODUCTION

It is often said that transportation is civilization, and no invention has done more to alter the face of civilization than the motor-car. Although railways had reached an advanced state of development by the end of the 19th century, the road traveller was restricted to the speed of the horse, just as his ancestors had been 100 years earlier, or, for that matter, 1000 years earlier. This meant that the great majority of people never travelled more than 20 miles or so from their homes, and villages that were not served by a railway were cut off to a degree quite unimaginable today. At first motor-cars did not alter the situation very much, for they were only available to rich people who had previously had their own carriages and horses. In a very short time—less than 30 years—more people owned cars than had ever owned horses, and so the whole pattern of holiday-making and visiting distant relations was changed.

The How and Why Wonder Book of Motor-cars describes the development of the car from earliest days to the present, with an account of the growth of motor sport, and also describes clearly and simply how a car works.

Today there are more cars on the world's roads than ever before, but with escalating oil prices the car is more threatened than ever before. However, short of a total ban on private motoring, it is unlikely that people will give up their cars, for the gift of going wherever one wishes, door-to-door, without the restrictions of timetables and railway networks, is one that has become a near necessity to 20th century man.

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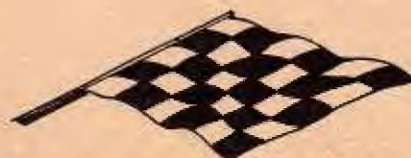
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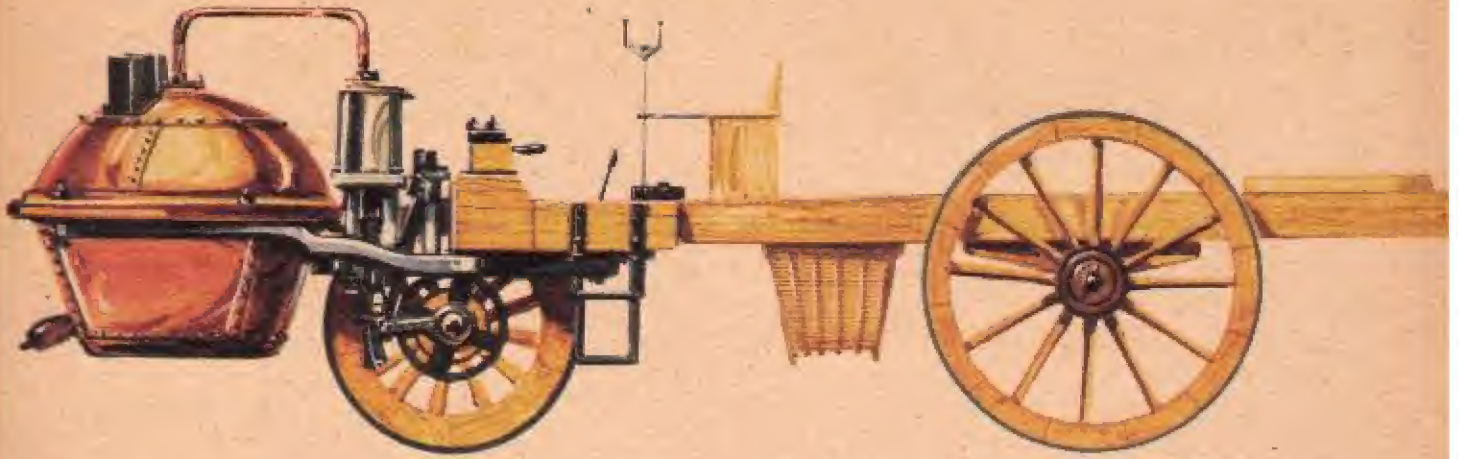
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CUGNOT'S TRACTOR

Nicolas-Joseph Cugnot's second steam carriage, dating from 1771. This historic vehicle can be seen today at the Conservatoire des Arts et Metiers in Paris.



The boiler and engine turned with the front wheel, which must have made for very heavy and difficult steering. Although he designed no more steam tractors, Cugnot was given a small pension by Napoleon in 1800, in recognition of his pioneer work.

The Development of the Motor-car

The first cars made for sale appeared less than a hundred years ago (in 1888, to be exact), but many experimental vehicles had been built before then. It is believed that a Jesuit missionary in China called Father Verbiest made a model steam-car in 1655, but for the first full-sized, self-propelled vehicle that could carry a man we have to move on more than a hundred years, to the France of King Louis XV. In 1769 Nicolas-Joseph Cugnot, an engineer in the French Army, built a large steam-powered tractor, intended for pulling heavy guns. It had three wheels, a two-cylinder engine, and an enormous boiler which stuck out ahead of the front wheel. The whole vehicle was on a grand scale; it weighed five tons and the chassis frame was as high as the roof of a modern saloon car.

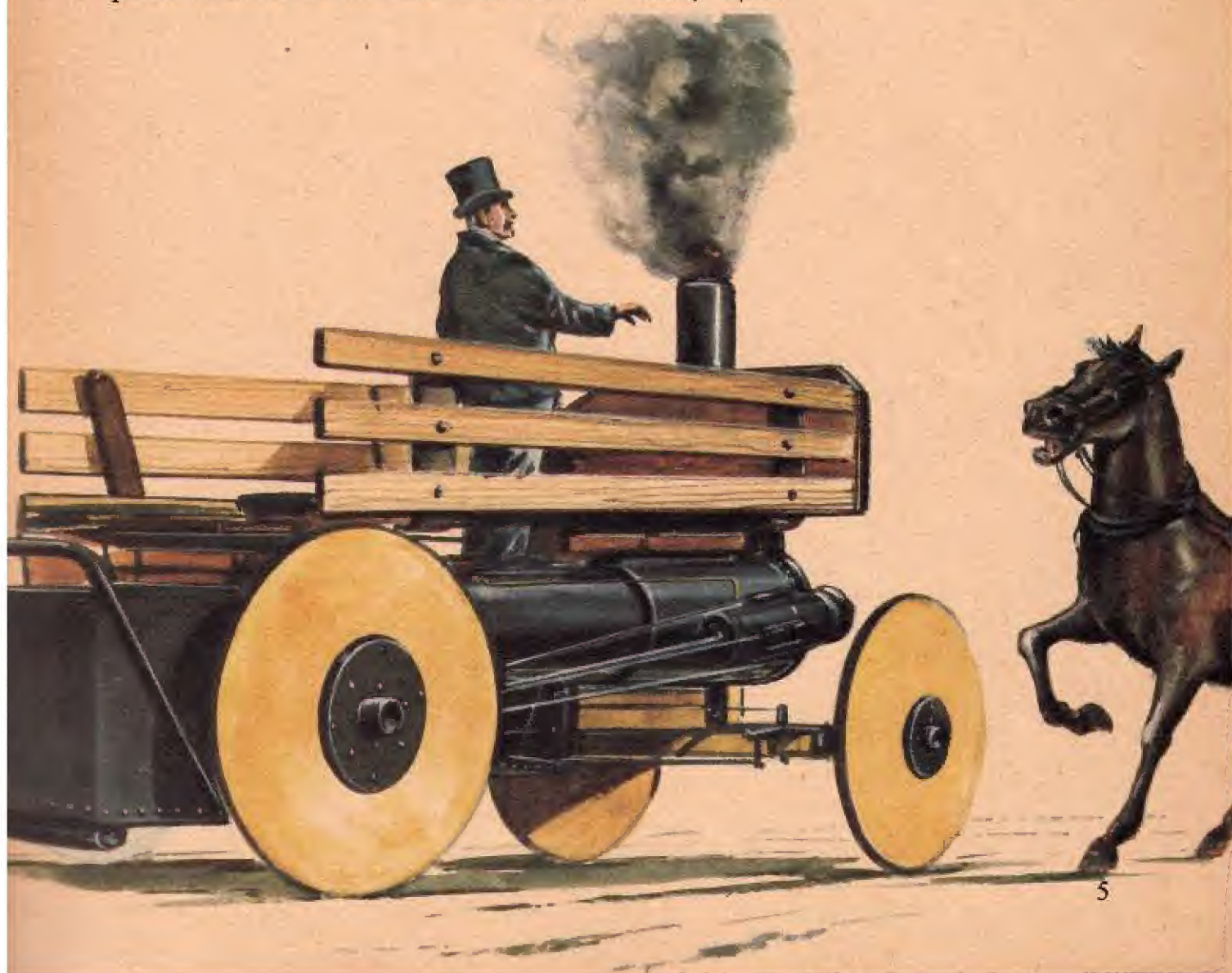
Cugnot made two of these machines, in 1769 and 1771, but they had two serious drawbacks which prevented them from being useful machines for the army. Their top speed was about 4 miles per hour, slower than a horse-team, and they had to stop every 15 minutes to build up a fresh head of steam. They were also very expensive. If he had received more encouragement Cugnot might have made a really practical machine within a few years, but the Minister of War who was supporting him fell from power. Cugnot could find no one else to finance his experiments, and he soon left the army and moved to Belgium. Although he lived for a further 33 years, he had nothing more to do with motor-vehicles.

Although railways were developed

successfully from about 1800 onwards, many years were to pass before any more motor-cars were made. Some steam-powered 'buses ran in London between 1829 and 1838, but nothing small enough to be called a car appeared until 1858. Then two inventors, the American, Richard Dudgeon, and the Englishman, Thomas Rickett, built small steam-cars. Dudgeon's, made in New York City, looked like a small locomotive with a bench seat on each side of the boiler. The engine consisted of two single cylinders, each driving one rear wheel. These wheels were made of solid wood, red cedar, and had iron tyres. When Dudgeon first tried out his car on Upper Broadway its noise and smoke scared the horses so much that police ordered the inventor back home

as quickly as possible. This was a problem that all early car inventors had to face. Dudgeon was luckier than most in having a country home at Locust Bay, Long Island. He continued his experiments there, and although presumably country horses were no more pleased by his machine than the New York ones had been, at least there were fewer of them. Steering was not an easy job. No one but Dudgeon seemed to be able to master it, and even he once ran into a barber's shop at Oyster Bay. Later, Dudgeon received a special police permit to run his car on the streets of Bridgeport, Connecticut.

When Dudgeon first tried out his car, the noise and smoke frightened the horses so much that he was ordered off the roads by the police.

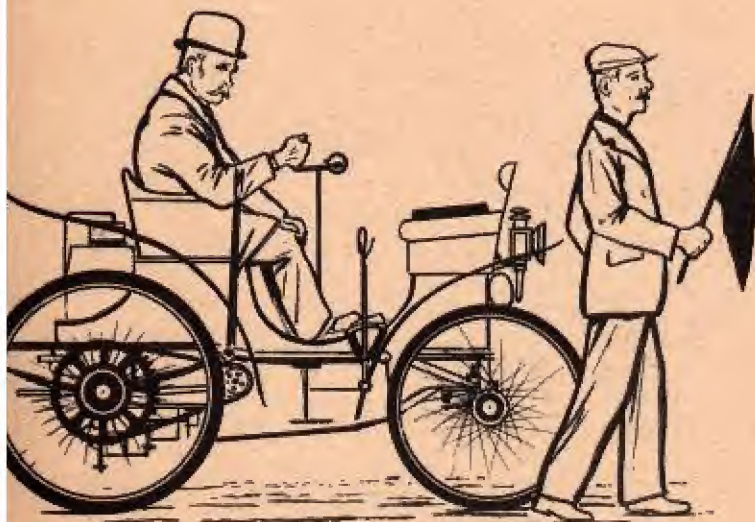


Thomas Rickett was an ironfounder from Buckingham who built several light steam-cars between 1858 and 1861. Unlike Dudgeon's, they had only three wheels, and a single front wheel was much easier to steer. Rickett demonstrated one of his cars to Queen Victoria and Prince Albert, and later sold several to members of the British aristocracy such as the Marquess of Stafford and the Earl of Caithness. The latter made a famous journey of 146 miles from Inverness to Barrogill Castle which included climbing a steep hill known as the Ord of Caithness. The journey was accomplished in two days with no mechanical trouble or breakdowns of any kind—a remarkable feat when one remembers that most of the early inventors were lucky to travel 20 miles without trouble.

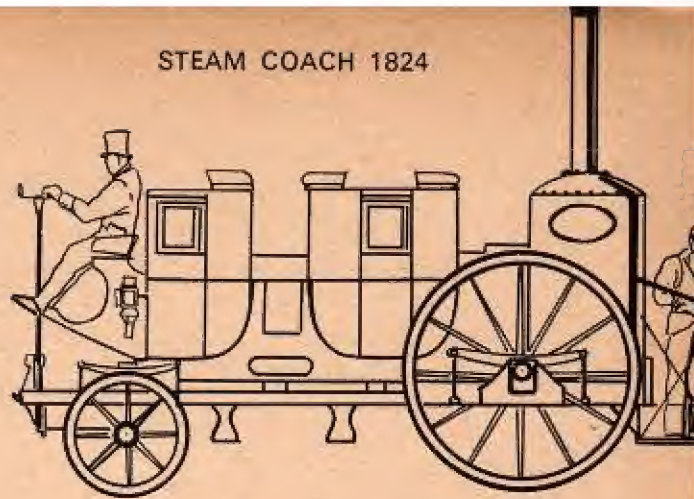
In 1861 the British Parliament passed the first of the Locomotives on Highways Acts, followed by another in 1865. Familiarly

What was the Red Flag Act?

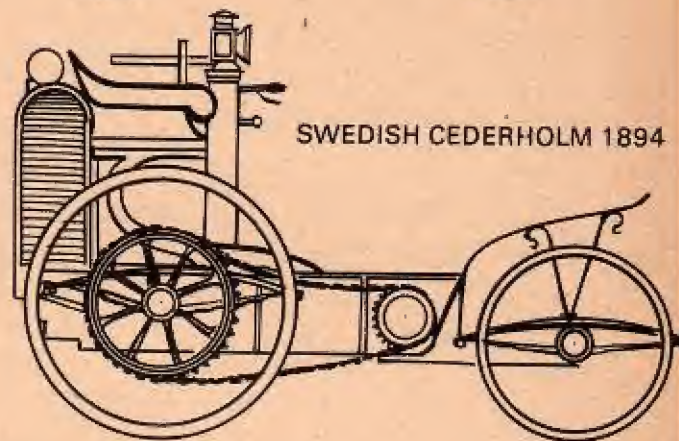
In accordance with the Red Flag Act of 1865, a man had to walk in front of a car to warn the unsuspecting public of the vehicle's approach.



STEAM COACH 1824



SWEDISH CEDERHOLM 1894



Two examples of early steam-cars.

known as the Red Flag Act, the latter restricted the speed of self-propelled vehicles to 4 miles per hour in the country and 2 in towns. Furthermore it insisted that a man carrying a red flag should walk at least 60 yards ahead of the vehicle, to warn the unsuspecting public, particularly those in charge of horses. As the whole idea of motor-cars was to convey people at a speed faster than a man can walk, these Acts, if obeyed, made the development of cars pointless. Although inventors continued their experiments at night, when they were less likely to be seen by the police, and at least one ingenious fellow found that if he dressed his passengers in firemen's uniforms and carried a hose he would be free from prosecution, they were gradually disheartened by the strict laws, and after 1870 few cars were made by British inventors.

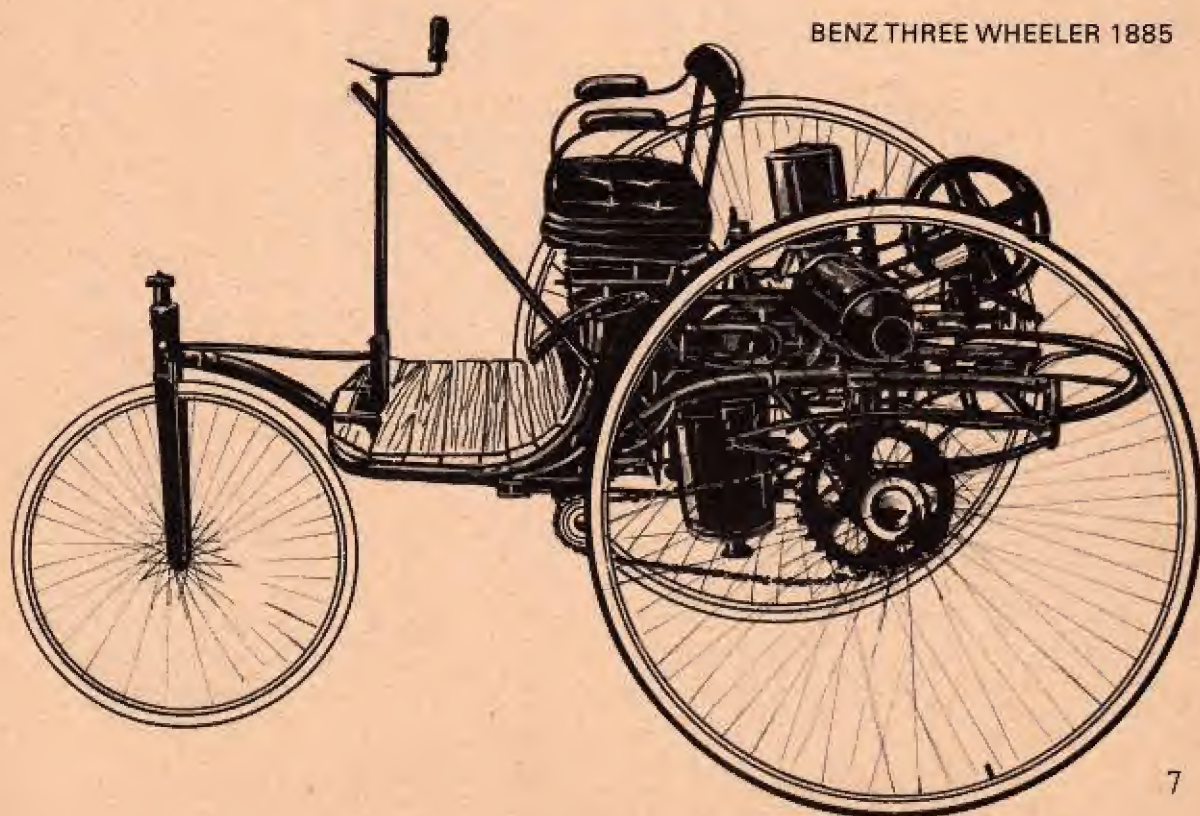
On the continent of Europe laws were

**What was the
importance of
Karl Benz?**

not so strict, and several experimental cars were made in France and Germany in the 1870s and 1880s. Among the German inventors was Karl Benz, who was a manufacturer of stationary engines running on coal gas. In 1885 he built a little three-wheeled car powered by a single-cylinder horizontal engine running not on gas but on petrol. It had a light, tubular frame and wire-spoked wheels like those of a bicycle. People today often forget the problems that men like Benz had to face. When he began work on his machine he had never seen a car, nor even a picture of one. He had to decide whether it should have three wheels or four, whether it should drive by front or rear wheels, and whether the engine should be at the front or back. His choice fell on three wheels, because such a car was easier to steer, and he mounted the engine directly over the

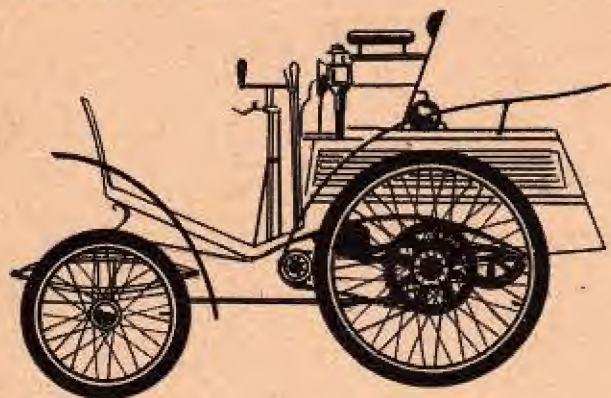
rear wheels so that there was no need for long driving-belts or chains. Late in 1885 Benz made his first trials of the car, at first driving just around the small courtyard of his factory, then out into the street. On the first of these excursions the car travelled less than a mile before it broke down and had to be towed by a horse back to the workshop, but gradually Benz was able to make longer journeys without trouble, and soon to travel from one town to another. He was very pleased with his car, but his partners in the gas-engine business thought he was wasting his time, and begged him to concentrate on a product from which they could all make money. However, Benz persevered, and in 1888 he felt that his cars were sufficiently good to be offered for sale. One factor that must have encouraged sales was a journey of 70 miles made by Benz' wife

Karl Benz's three-wheeler of 1885. This car was powered by a single-cylinder horizontal engine running on petrol.



BENZ THREE WHEELER 1885

FOUR WHEEL BENZ



The four-wheel Benz which superseded the three-wheeler after 1893.

Bertha and their two sons, 15-year-old Richard and 13-year-old Eugen. People felt that if one of these new-fangled cars could be driven by a woman and two boys, it should not hold any terrors for a man. The first cars that Benz sold were three-wheelers similar to his first prototype, although with more powerful engines that gave them a maximum speed of 15 miles per hour (mph). Once he had mastered the problems of steering a four-wheeler, which was in 1893, he abandoned three-wheelers for good. By the end of 1893 he had sold 69 cars, which may not seem much for six years, but it was more than any other car maker in the world had achieved. In 1894 he sold 67, in 1895, 136, and in 1896 a total of 181 cars left his factory at Mannheim, which was now no longer concerned with gas-engines as Benz had parted company from his former partners. Benz cars were made under licence in France, Britain and the United States,

and for many people the name Benz was synonymous with the motor-car, just as Ford was to be 20 years later. This is the great importance of Karl Benz, that he not only made the first successful petrol-engined car, but he also sold more cars than anyone else for the first 10 years of the motor era.

The adventures of Karl Benz were repeated many times during the 1890s as inven-

How did the motor industry develop?

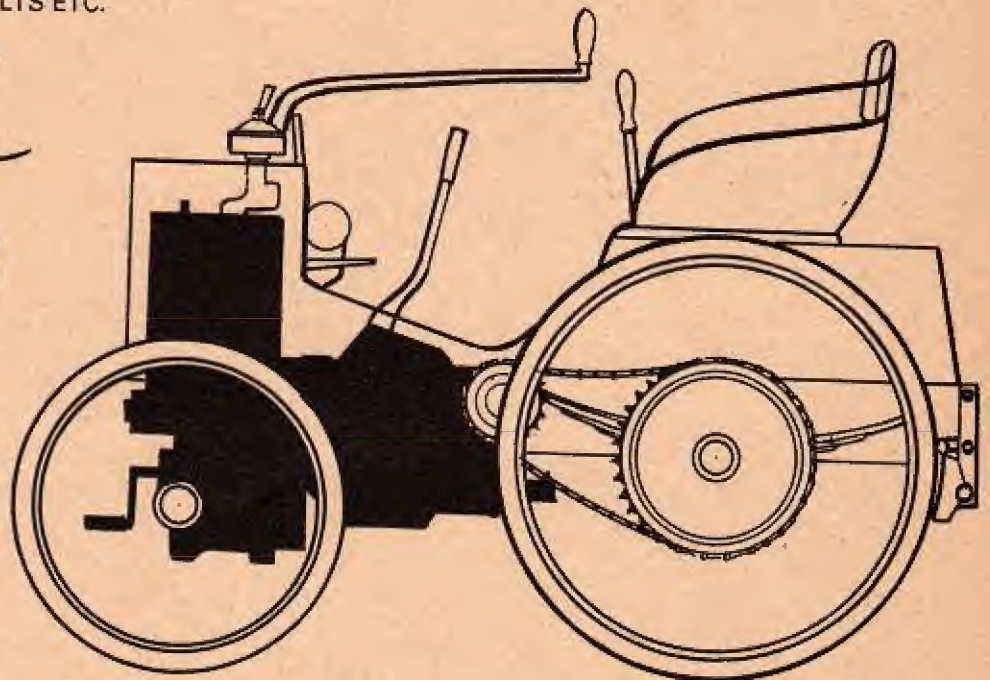
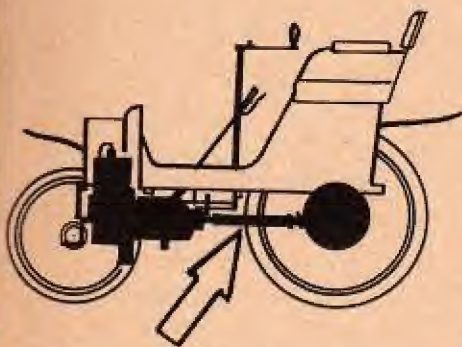
tors and engineers in various countries heard about the motor-car and were tempted to try their hand at making one. The bicycle industry was expanding at a tremendous rate during this period, and many bicycle firms began to make cars, at first experimentally and then for sale to the public. Among the better-known examples were Humber, Rover and Swift in England, Clément in France, and Pope in America. Bicycle features which were carried over in the design of early cars included frames of tubular steel and wire-spoked wheels. Other industries which gave birth to motor-cars included sewing machines (the White company of Cleveland, Ohio, USA), typewriters (Adler of Frankfurt, Germany, who still make typewriters although they have not built a car for over 30 years), and sheep-shearing machinery (Wolseley of Birmingham, England). The two pioneer companies, Benz and Daimler, had a tremendous influence on the spread of car manufacture; as we have seen, Benz cars were made under licence in several countries, while the importance of Daimler lay in the use of his engines by the two pioneer French manufacturers, Panhard and Peugeot. Panhard took an important step forward in 1891 when he moved the engine to

the front of the car, under a bonnet, driving the rear wheels via a gear-box and chains. Apart from the chains which were soon replaced by a propel-

ler shaft, this layout became the standard one until quite recently when a number of rear-engined designs appeared.

The French manufacturer, Panhard, took a great step forward in 1891 when he built a car with the engine at the front under a bonnet, driving the rear wheels via a gear-box and chains.

A RENAULT OF 1899 SHOWING LIVE REAR AXLE INSTEAD OF CHAINS OR BELTS ETC.

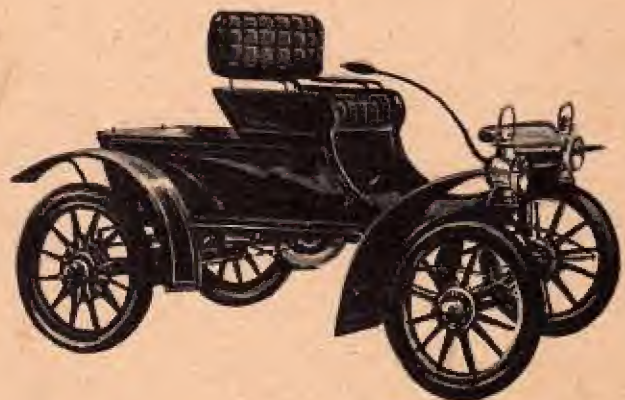


PANHARD'S CAR OF 1891 SHOWING ENGINE AND GEAR BOX IN SOLID BLACK, BUT CHAIN DRIVEN.

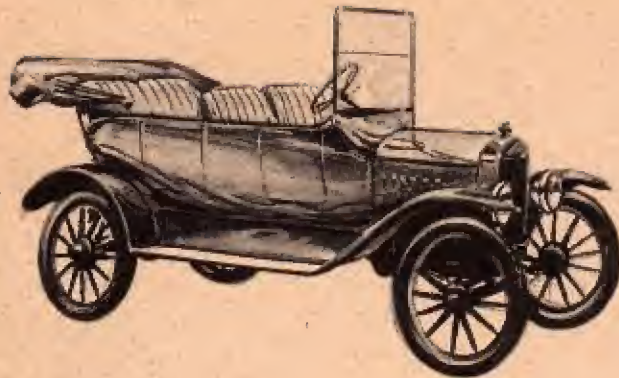
The first car factories were very small by modern standards, and each car was made by hand. Demand was not very great, not only because prices were high but because it took some time for people to get used to the idea that a motor-car might be a useful thing to buy. The first man to build cars, in what came later to be called mass-production, was an American, Ransom Eli Olds. In 1901 he launched a light two-seater with the engine under the seat and a curved dashboard ahead of the driver's feet, which gave the car its name, the Curved Dash Olds. More than 400 were made in the first year of production, and this figure rose to

Curved Dash Oldsmobile runabout, 1902. It had a top speed of 20 mph, and cost the equivalent of £130

CURVED DASH OLDSMOBILE



FORD T.

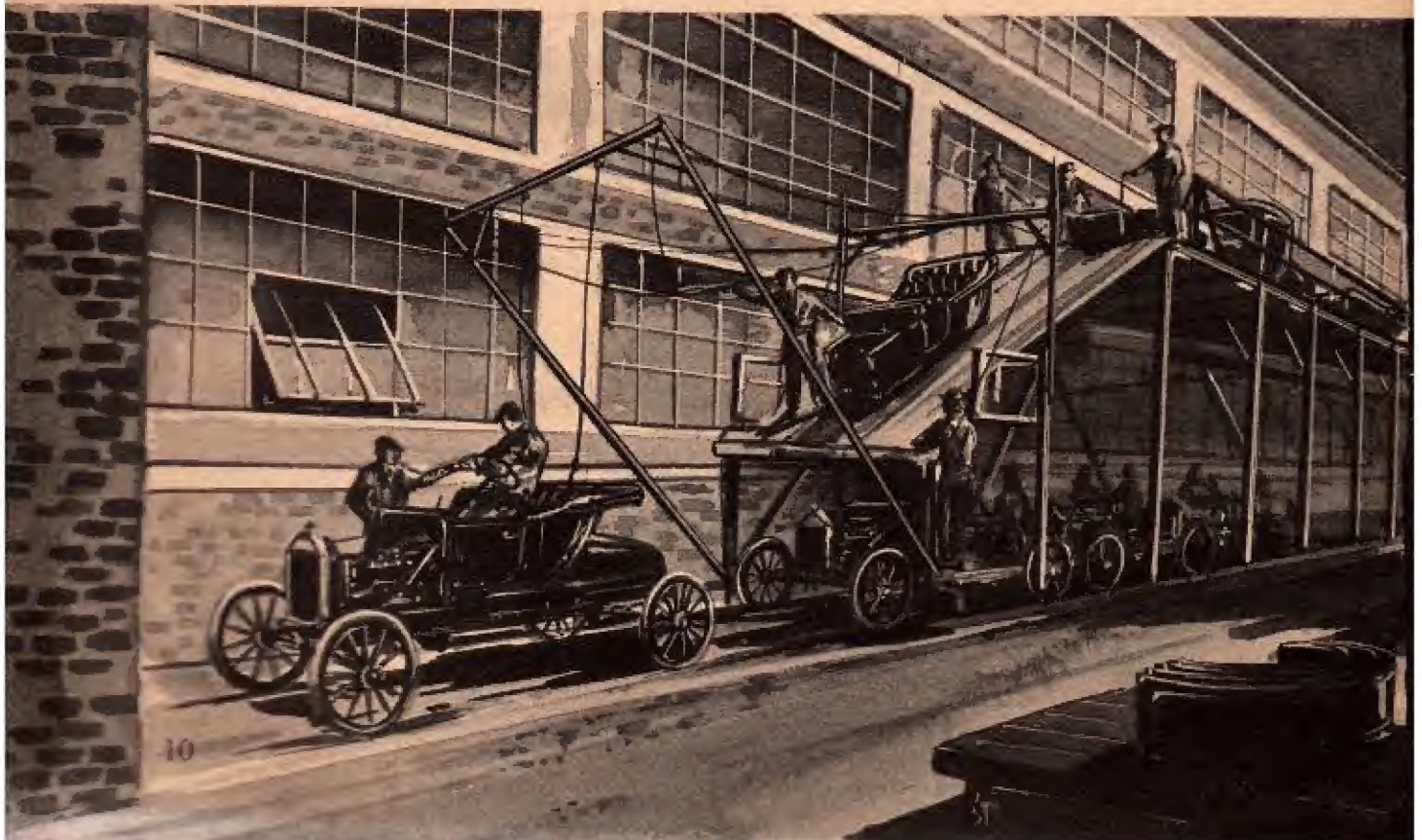


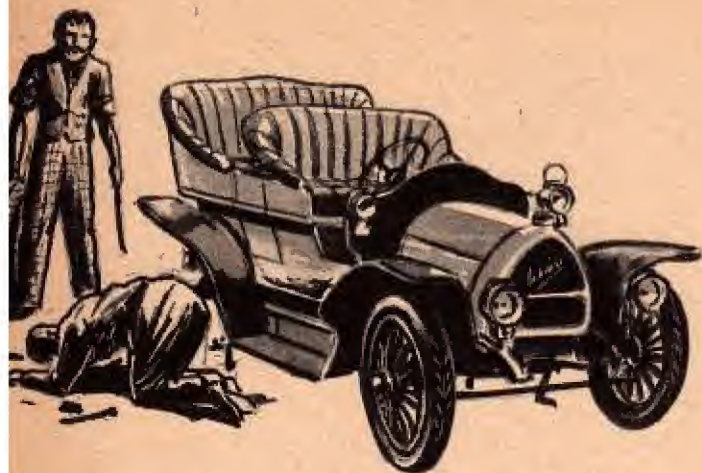
A Model T Ford Tourer of 1917. This became the best selling car in the world soon after it was introduced.

2,500 in 1902, 4,000 in 1903 and 5,508 in 1904. This was more than twice as many cars as those from the next most popular manufacturer, and made a fortune for Olds, whose Oldsmobile cars are still made today. In 1906 Olds was overtaken by Henry Ford in the

production race, and two years later Ford introduced the Model T which soon became by far the best-selling car in the world. Total production during the Model T's first year was 17,771, but within four years Ford factories were turning out more than *ten times* this figure. This was made possible by the conveyor-belt system, whereby the cars moved slowly along on a belt, and parts for assembly were brought to each worker on a fixed, timed schedule. As he sold more and more cars, Ford was able to reduce the price of each, so that a car which cost \$850 in 1908 cost only \$360 in 1916. In 1923 the cheapest Ford cost only \$290, and more than 1,817,000 were sold. For many years no other car maker rivalled Ford's figures, but many tried, and the result was that by the outbreak of the First World War in 1914 the passenger car was a familiar sight in all industrialized countries, and had spread to all five continents of the world.

An early factory assembly line at the Ford Motor Company — about 1913. This mass-production technique enabled Henry Ford to produce many more cars than before and at lower prices.





Mending a puncture. Once wheels were made detachable, mending a puncture became a much easier job.

One of the main reasons why cars did not sell widely in the very early days was that they were unre-

What problems did the early motorist have?

liable and it was a rarity for a pioneer motorist to cover more than 30 miles without an involuntary stop for one reason or another. Although engines and transmissions did give trouble, the biggest headache was caused by punctures to the tyres. The first cars had tyres of solid rubber which gave a bumpy ride even at very low speeds. As cars became capable of higher speeds the shaking caused by solid tyres would have become unbearable. Fortunately the pneumatic tyre (filled with air) had just been invented for use on bicycles, and it was soon adapted to the motor-car. At first many car-designers thought that it would never be a success. In the 1895 Paris-to-Bordeaux race only one car had pneumatic tyres, and it had so many stops to change tyres that it was disqualified from the race. However, the more comfortable ride offered by the pneumatic gradually persuaded motorists



An American car being driven over a corduroy road in the 1930s. In the days before tarmac road surfaces, laying logs across the road in this way was one method of trying to cope with the mud.

in its favour, and by 1900 hardly any private cars were made with solids. Wheels were not detachable in those days, and a puncture meant that the tyre had to be removed from the wheel. An alternative to this was the Stepney wheel, which was a spare wheel and tyre which could be mounted next to the punctured tyre and wheel, so that the car could be driven to the nearest garage.

As if unreliable engines and punctures were not enough, the early motorist had to cope with roads which were deep in dust in summer and rivers of mud in winter. In fact, many modern cars with their low ground clearances would have not been able to travel at all on a typical country road of 1900. Although town roads had been paved for some time, main roads in the country did not receive tarmac surfaces until shortly before 1914, and minor country roads not for another 20 or 30 years after that. Roads in America were on the whole worse than in Europe, and one method of coping with mud was the corduroy road, on which logs were laid across as closely as possible. One

can imagine what sort of jolting that gave to the passengers, pneumatic tyres or not!

The policeman was a hated figure to motorists, especially in countries like England where speed limits were ridiculously low, and strictly enforced. Up to 1896 the Red Flag Act kept speeds down to 4mph, although the man with the flag was no longer insisted on after 1878. Then a new Act raised the limit to 12mph, which was further raised to 20mph in 1903. Many cars were capable of more than this, and the temptation to let one's car out to its maximum landed countless motorists in the police courts, where fines of up to £20 were usually imposed. In theory, the 20mph limit lasted until 1930, which was quite ridiculous, as by this date even the smallest cars could do nearly 50mph.

A sports car is a road-going car of

How did the sports car emerge?

higher performance than average, intended more for enjoyable motoring than for carrying capacity.

In the early days of motoring the only way to increase the power of an engine was to make it larger, either by increasing the size of the cylinders or by adding more cylinders, making a two-cylinder engine into a four, and then a four into a six. This resulted in some enormous engines, particularly in racing cars which by 1906 were as large as 15 litres' capacity. At this time there were no sports cars as such, and anyone who wanted a really fast car for road use would buy a racing car a year or two old and fit it with a two- or four-seater body and road equipment such

MERCEDES 1904



Some examples of early big-engined cars and sports cars.

DELAUNAY-BELLVILLE 1910



CHITTY-CHITTY-BANG-BANG 1921



HISPANO-SUIZA 1912



BUGATTI 1927



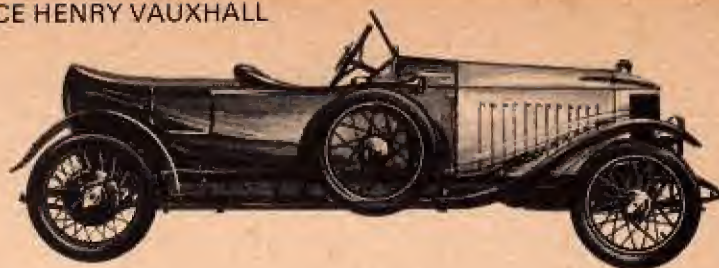
BENTLEY 3 LITRE 1925



WIMLER DOUBLE-SIX 1930

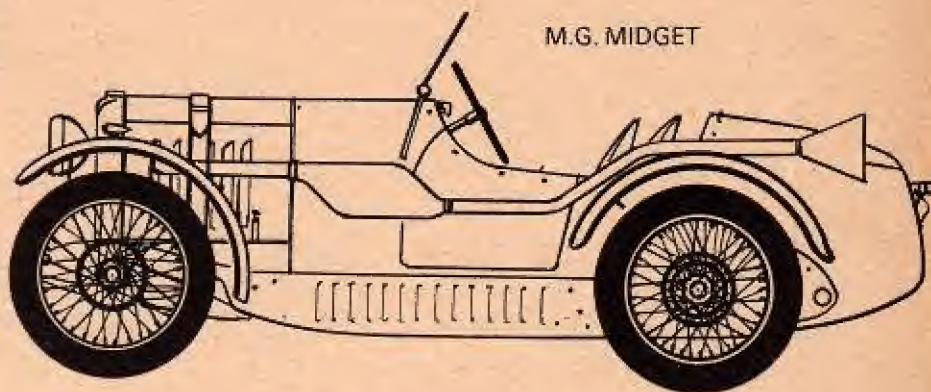


PRINCE HENRY VAUXHALL



AUSTRO-DAIMLER

M.G. MIDGET



as lamps and mudguards. The resulting car was very fast, but could be difficult to handle and was very heavy on fuel. In the years 1908 to 1910 two men, an Englishman and an Austrian, began to study engine design in order to obtain greater power from a relatively small engine. Laurence Pomeroy worked on the 20hp Vauxhall to such good effect that he raised the output from 38bhp to 60bhp without increasing the engine size at all. Ferdinand Porsche was the chief engineer for the Austrian Daimler company, and he designed a four-cylinder engine with the then unusual feature of an overhead camshaft that could operate at speeds of up to 2,300rpm. Both the Vauxhall and the Austro-Daimler were entered in the 1910 Prince Henry Trial, a 2,000-mile tour of Germany organised by Prince Henry of Prussia, brother of the Kaiser. The Vauxhalls were unplaced, but Austro-Daimlers took the first three places, and the Prince Henry model was put on the market. The

Some early examples of sports cars in use between 1910 and 1930.

significant point about it was that it was the fastest and most expensive model of a large range of cars, but it was by no means the biggest. The path to power by sheer size was abandoned in favour of more scientific design, and other manufacturers began to follow suit. This is not to say that large-engined cars were no longer made, but they tended to be tourers rather than sporting cars. The term 'sports car' was not used until after the First World War, but cars such as the Prince Henry Vauxhall, three-litre Sunbeam and others meet all the definitions that have been given to the breed. At first they were expensive, but by the mid-1920s quite reasonable small two-seater sports cars were being made, and this kind still exists today in cars like the M.G. Midget.

Although the Ford Model T made motoring comparatively cheap for Americans,

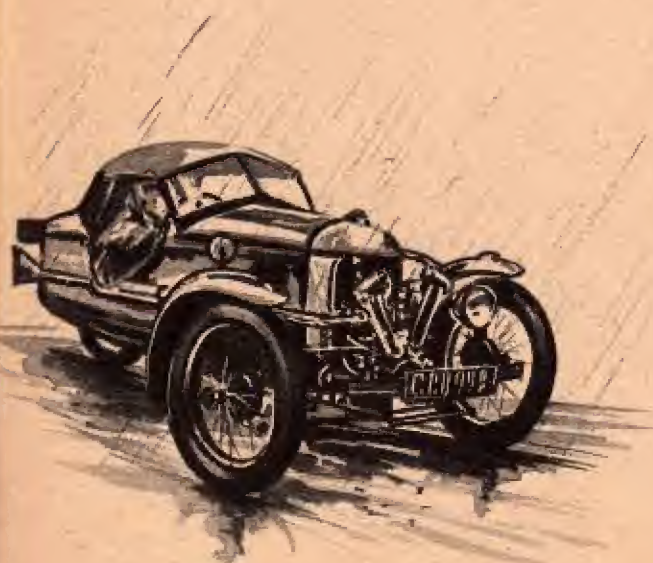
What was a cyclecar?

the average car was still an expensive item in Europe, and those who could not afford cars bought motor-cycles instead. These suffered from the same drawbacks as they do today, accommodation limited to two people at most, and discomfort in wet weather. Around 1910 a new type of car appeared in Britain and France which used a motor-cycle engine and belt drive in a very light wooden frame, with a two-seater open body. Sometimes the seats were side-by-side as in larger cars, sometimes in tandem as on a motor-cycle. Because of their components they came to be known as cyclecars. They were mostly the products of small workshops run by young men who had been motor-cyclists, and none of the large, well-established firms turned to the cyclecar. However, the type grew in popularity up to the outbreak of war in 1914, and over a hundred firms in Britain alone joined

A Morgan cyclecar in bad weather. A cyclecar could provide performance at a lower price than most cars but the weather protection offered was often not much better than that of a motor-cycle.

the cyclecar craze, with nearly as many in America and France. The cyclecar had its critics—engineers felt that using the belt or chain drive was a backward step, while the weather protection offered was sometimes not much better than that of a motor-cycle—but it did provide performance at a lower price than any other four-wheeler. A 1914 G.N., one of the best-known makes, gave its owner 55mph for less than £100.

Some cyclecars had only three wheels; the most famous of these was the Morgan, which won a number of races in 1913-14 and was still made in three-wheeler form as late as 1950. Some three-wheelers were very small; the Cambro, made in London in 1920, was a single-seater which weighed only 165lbs, about the same as an average man. Its fuel consumption was claimed to be 100mpg, but it could do no more than 28mph. The heyday of the cyclecar was from 1912 to 1922, after which the 'large car in miniature', such as the Austin Seven with four cylinders and four seats, came onto the market in large numbers and drove the cyclecar from the scene. Very few survive today because of their flimsy construction.

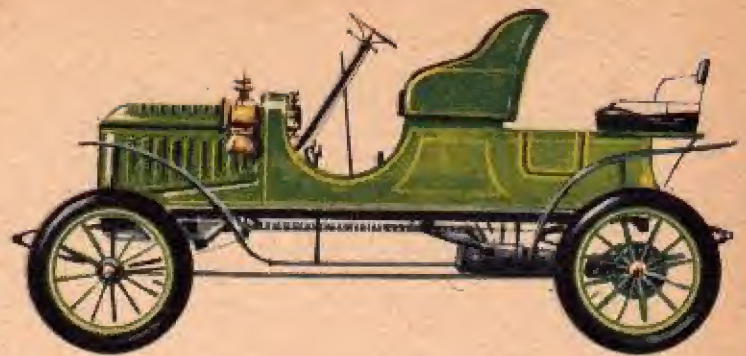


G.N. CYCLE CAR

STANLEY LOCOMOBILE 1900-1901



STANLEY STEAMER 1907



STEAM POWERED RACING CAR



Examples of steam-buggies and a steam-powered racing car that were extremely popular between 1898 and 1902. These vehicles showed great improvements when compared with the early models of pioneers such as Rickett and Dudgeon.

We have seen that before the arrival of the internal-combustion engine steam-cars were supreme, and the type did not die out just because petrol engines became popular. In America especially, the steam-buggy was made in large numbers, and from 1898 to 1902 it outsold petrol-cars. These light steamers, of which the Stanley and the Locomobile were the best known, were very different from the machines of pioneers like Rickett and Dudgeon. For a start, they used paraffin and not coal for fuel, and their tubular frames and wire wheels were derived from the bicycle industry. Steering was by tiller, and most of the early steam-buggies had only two seats. Their top speed was about 25mph, no less than that of a small petrol-car of the same date, and once they were running they had several advantages over their internal-combustion rivals.

Why did steam- and electric-cars not survive?

They were almost silent except for a gentle hiss when accelerating, and they had no gear-boxes owing to the great flexibility of the steam-engine which is as efficient when working at low speeds as at its maximum. This absence of gear changing was a popular feature in the days when the gear-box was the most difficult thing a motorist had to master. Unfortunately, there was a great drawback to the steamer—the time it took to start up in the morning. Steam had to be ‘raised’ before the car could move off, and this could take anything up to 45 minutes. On one car there were 26 separate steps listed in the starting procedure, beginning with “Head car into the wind”! Although there was no gear changing, in other ways the steam-car needed more skilled handling than the petrol one. A good head of steam had to be maintained at all times, otherwise the car might have to be stopped at the foot of a hill for a few minutes in order to raise enough

steam for the climb. To eliminate these drawbacks, particularly that of starting, the steamer became more complex and expensive, so that by 1910 it was among the higher-priced cars on the market. By this time the petrol-car was more reliable, and when in 1914 the electric starter appeared the appeal of the steamer was still further reduced. Only one make struggled on in America, and none in Europe, and by the end of the 1920s no steam-cars were being made.

Another motive power which has some of the advantages of steam is electricity. The first officially recorded Land Speed Record was obtained by an electric-car, at a speed of 39.2mph! This was in 1898, and by the following year the record had been raised to 65mph, again by an electric-car. However, on the whole, electrics were slow, dignified vehicles, mostly used for town work. They were usually closed cars with very short bonnets under which the batteries were housed, and tall windcreens and windows which led to their nickname, 'mobile china closets'.

A typical electric delivery vehicle in use today.



A Ford experimental electric-car. In comparison with petrol-driven cars, these had the advantage of being silent, simple to drive and without the unpleasant smell of petrol.

They were favoured by lady drivers who appreciated their silence, simplicity of driving and absence of smell. Control was by a single pedal which increased the speed as it was released, acting like an accelerator in reverse. When it was fully depressed, the brakes came on. The great drawback of the electric was its limited range, usually not more than 40 miles, before the batteries needed changing or recharging. This did not matter so much if the cars were restricted to town use, and could be kept at night in a garage which had charging facilities, but there were not many people who could afford to keep a car solely for town work. As with the steamer, the electric lasted longer in America than elsewhere, but by the mid-1920s there were hardly any being made. Electricity is still widely used for milk delivery, and some experimental passenger cars have been made recently, but none are for sale yet.

It has been said that the first 10 years of the motor-car's history (1895-1905) were devoted to making it go, and the next 10 years to making it go well. This it certainly did by 1915, but on the whole it was not possible to combine performance with luxury or even comfort, and if you wanted a cheap car it was neither comfortable nor fast. During the 1920s the luxury car became faster, the fast car more luxurious and the cheap car very much better than before. Also, the numbers of cars on the road increased dramatically. At the beginning of 1919 there were only 78,000 cars in Great Britain, a figure which had risen to 998,489 by 1929, and this increase was paralleled in most industrial countries of the world. America had become motorised before any European nation, and so had a high production even in 1919, but the figures for annual car output rose from 1,651,000 in 1919 to 4,455,178 in 1929. This meant that the motor-car became a familiar and accepted part of daily life, seen in every village in the land. Roads were now built with the motorist in mind; hard surfaces came to all but the smallest country lanes, and special by-pass roads such as the Kingston By-Pass took traffic away from country towns. In cities, familiar features such as white lines in the centre of the road, traffic lights and roundabouts all made their appearance in the 1920s.

The cars themselves showed many improvements, particularly the small cars. Cyclecars were made at the beginning of the decade, but soon gave way to proper light cars with all the features of more expensive machines. Two cars in particular led this trend, Britain's Austin Seven and France's Citroën 5CV. The 'Baby Austin', as it

What were the main developments of the 1920s?

of the motor-car's history (1895-1905) were devoted to making

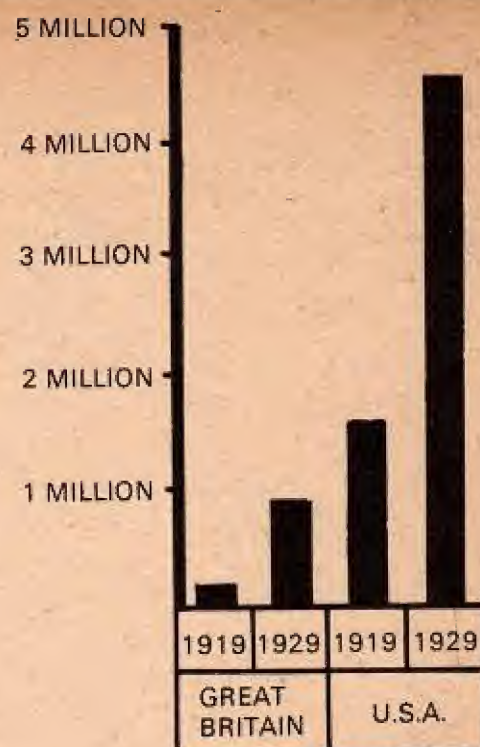


Chart to show the rise in the output of cars between 1919 and 1929.

was soon called, appeared in 1922 and although it was only 8 ft. 10 ins. long it could seat four people and had a top speed of 45mph and front-wheel brakes. By 1923 it was selling at the rate of 200 a week, and the price was only £165. It was made as a sports car and as a racing car, and was very popular with young women, just as the Mini was in the 1960s. A slightly larger car which was also made in large numbers was the Morris, familiarly known as the 'Bullnose' because of the rounded radiator which it had until 1926. William Morris, later Lord Nuffield, followed Henry Ford's practice of cutting prices each year in order to increase sales, and although it was a risky move it paid off for Morris, who made more cars than anyone else in Britain in 1926.

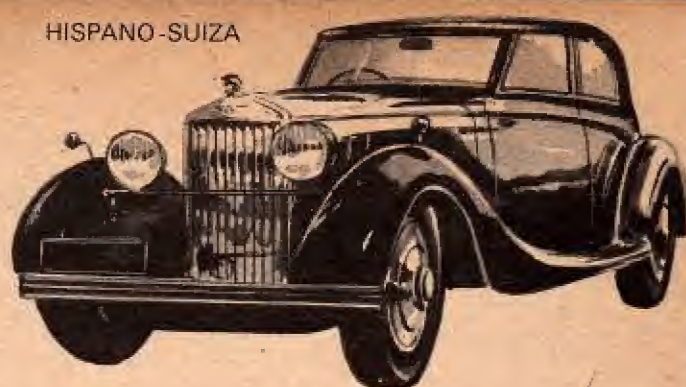
At the other end of the price scale there were some magnificent cars made in the 1920s. Every country had its luxury cars, and for some reason many of them had double-barrelled names: Britain's Rolls-Royce, France's Hispano-Suiza, Italy's Isotta-Fraschini,



BABY AUSTIN



CITROËN 2 CV



HISPANO-SUIZA

ROLLS-ROYCE PHANTOM II



Two popular European cars of the 1920s and 1970s.

Two luxury cars of the inter-war period.

Germany's Mercedes-Benz and America's Pierce-Arrow. They were not necessarily the most advanced designs, and some, like the Rolls-Royce Silver Ghost, were distinctly old-fashioned, but they were made by hand by highly skilled craftsmen, and most of them were available only as bare chassis. Bodies came from specialist coach-builders, many of whom had been in business for over 100 years, having started with horse-drawn carriages. One of these bodies might take several months to make, and cost up to £1,000. When this was added to the chassis price of over £2,000, a top quality car might cost £3,500, or more than £20,000 in today's money. Thus a Rolls-Royce or its equivalent was relatively more expensive then than now, although most people would agree that the craftsmanship was better. At the beginning of the 1920s most luxury cars had six-cylinder engines, but the Isotta-Fraschini was a straight eight and, as the years passed, more and more makers turned to the eight cylinders

for greater smoothness and silence. The peak was reached at the end of the decade when 12 cylinders mounted in V-formation were made by a number of firms, and two, both American, built V-16s for a short time.

The sports car became much more widespread during the 1920s, and was available in all price ranges from under £200 to well over £1,000. France made many small sports cars with pointed tails and staggered seats, and in Britain the most popular were the Austin Seven and the M.G. Midget, which was developed in 1928 from the Morris Minor. The classic sports car of the period was the open four-seater, typified by the three-litre Bentley and the Vauxhall 30-98. These cars had top speeds of over 80mph, and could cruise comfortably at 60-65mph for long journeys, assuming the roads were up to such speeds, which few were. France was the great country for long, high-speed journeys, for the roads were very straight even if the surfaces were not all that good.

Up to the mid-1920s the closed car was

When did closed cars become popular?

comparatively rare, being mostly seen as an

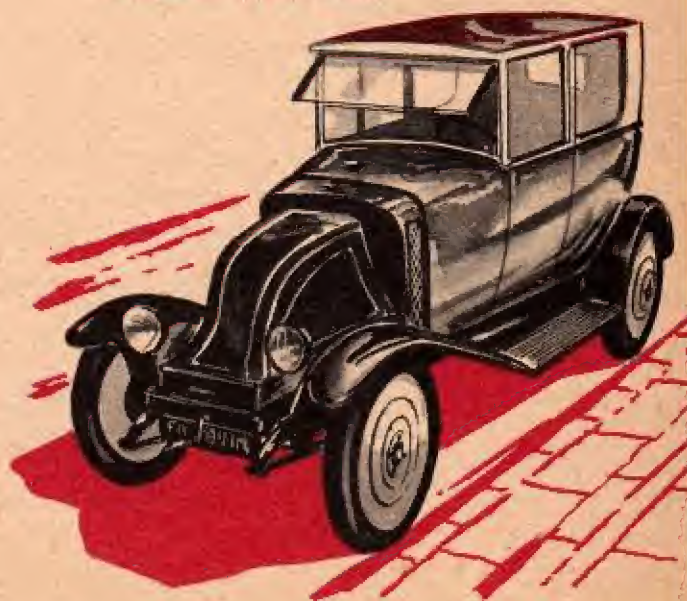
expensive chauffeur-driven limousine or as a doctor's coupé. The latter was a fully-enclosed two-seater, particularly favoured by medical men who had to turn out in all weathers. The average family car, though, was an open four- or five-seater, with a hood which could be brought forward and fastened onto the windscreen. This was a difficult and clumsy operation, and the 'one-man hood' was enough of a rarity to be advertised as such. Instead of wind-up windows, the family tourer had side-screens which had to be fitted in position. These were made of talc rather than glass, and after a few years of use they became yellowed and stained and difficult to see through. The two objections to the fully-enclosed body were weight, which was of great importance when engines were not very powerful, and cost, since closed bodies were hand built and took far more materials and labour than a simple tourer body. Both these problems were overcome with the introduction of the all-steel saloon body, which was first used by the American

Dodge company in 1916. Ford followed soon after, and the steel saloon which could be mass-produced came to Europe in 1925 when the French manufacturer André Citroën introduced a four-door saloon on his 10hp chassis. In England this cost only £100 more than the open tourer, and this price differential was reduced in later years. Other manufacturers followed Citroën's example, and within a few years the closed car became the norm, and the open one quite a rarity. In Britain 46 per cent of cars registered in 1927 were closed, but by 1931 this figure had risen to 92 per cent. The open tourer disappeared from many manufacturers' ranges by the mid-1930s, and the open cars that remained had much better equipment, with wind-up glass windows and, in America, power-operated hoods by 1939. A result of the arrival of the closed car was that interior heaters became more common. Motor-ing in the 1930s was much more comfortable, though not necessarily faster, than it had been 10 years earlier.

Left: A doctor's coupé. Model T Ford, 1919. These early closed cars were used only by the very rich and by doctors who had to visit patients in all weathers. Below: One of the earliest steel saloon cars, the 1923 Renault 6CV. These closed cars became the norm when the all-steel saloon body could be mass-produced.



RENAULT 6 CV 1923.



FIAT 500
ITALY



CITROËN
FRANCE



VOLKSWAGEN
GERMANY



TATRA
CZECHOSLOVAKIA



From about 1900 to the outbreak of war in 1939 most cars had the same basic layout, with a front-mounted engine, usually with its cylinders in line, driving through a gear-box immediately behind the engine to the rear wheels. In the 1930s a few designs broke away from this time-honoured system in two ways, either by driving the front wheels or by mounting the engine at the rear of the chassis. The former system, which was the more common, was used in the French Citroën *Traction Avant* (Front Drive), the German Adler and D.K.W., and the Czechoslovakian Aero and Jawa. Rear engines were employed by Tatra, another Czech make, and by Ferdinand Porsche in his Volkswagen, which was just going into production when war broke out. British and American manufacturers did not go in for front-wheel-drive or rear engines at this time, with exception of the small-production American Cord. After the war ended in

What were the main developments after World War I?

A selection of European cars. After the Second World War manufacturers resumed production with their pre-war designs, but soon introduced many new models showing great originality.

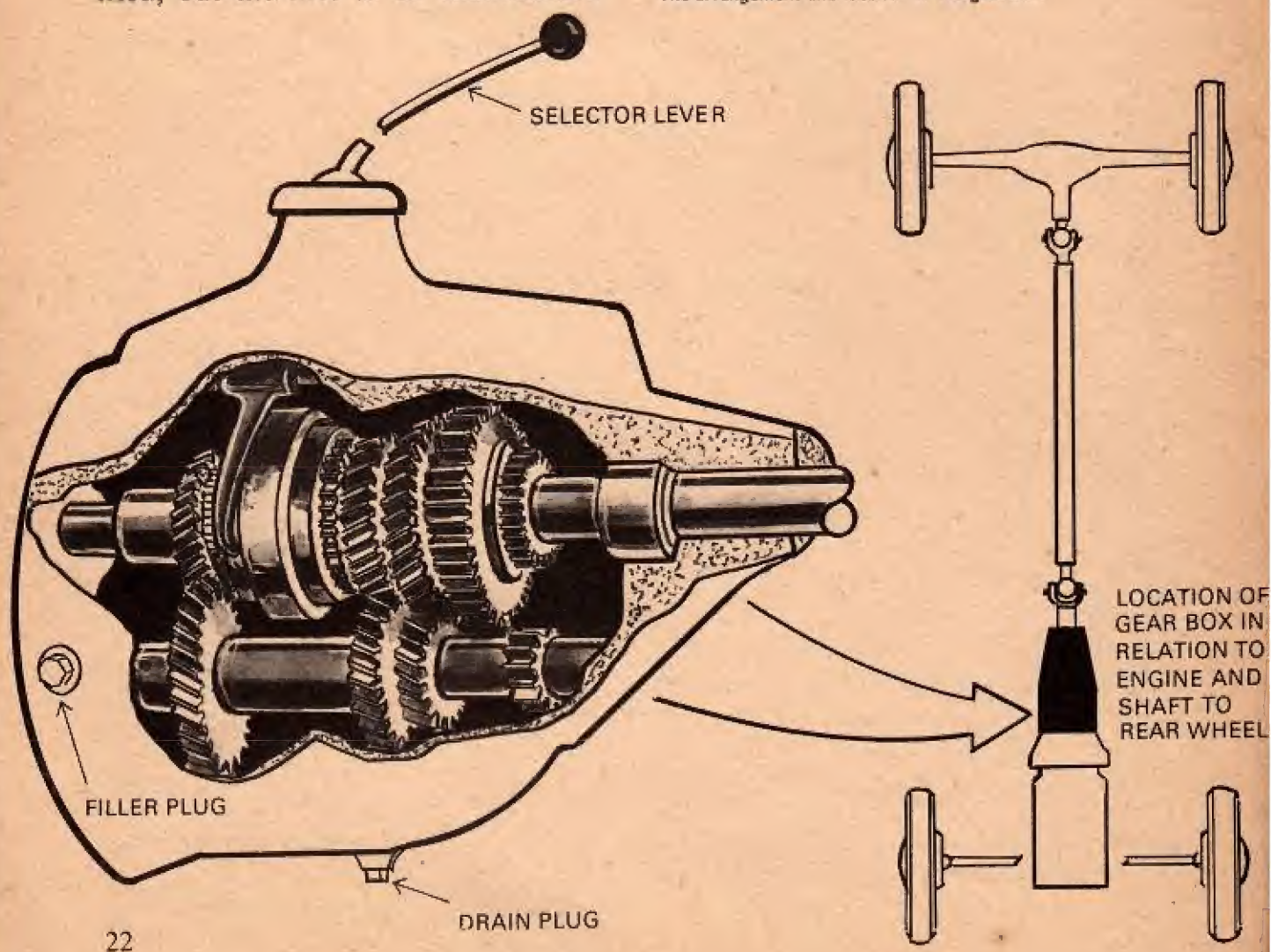
1945 most manufacturers resumed production with their pre-war designs, but soon new models appeared, and these showed more originality. Renault introduced their '4CV', a four-door saloon with small rear-mounted four-cylinder engine, Citroën had the front-wheel-drive '2CV', and a few years later Fiat launched the rear-engined '600' and '500'. Britain joined the trend with the rear-engined Hillman Imp and front-wheel-drive Austin/Morris Mini, so that by the 1960s one could no longer say that there was a 'conventional' arrangement of drive systems. In recent years rear-engined layouts have fallen into disfavour, for two reasons. The weight of the engine at the back of the chassis makes the car likely to swing out during fast cornering, and there is less room under the bonnet for luggage than in the conventional boot. Many popular

European cars of today use front-wheel-drive, either with the engine in the traditional in-line position as in the Renault 5, 12 and 16, or mounted transversely, as in the British Leyland Minis, Simca 1100 and Fiat 127. Among surviving rear-engined cars are the Hillman Imp and the Czechoslovakian Skoda, but these are old designs, and when replacements come they are unlikely to have rear engines.

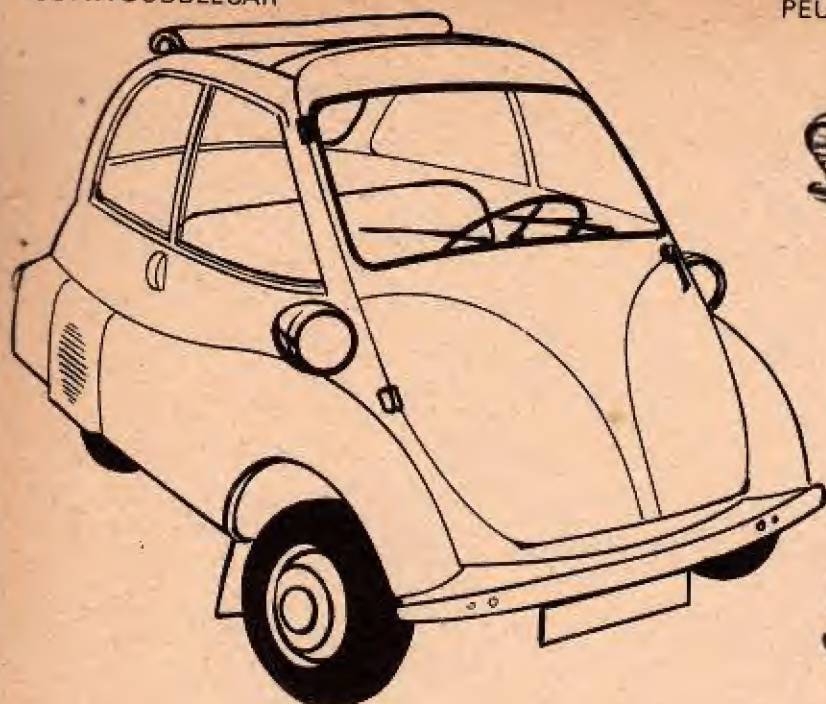
Another important development of spread the post-war period has been the of automatic transmissions. Gear changing has been an inevitable but annoying aspect of driving since the earliest days, although it has been greatly simplified since the arrival of the synchromesh gear-box in the 1930s. Various automatic systems have been tried, but the first to be standardized

on a mass-production car was the Hydramatic drive introduced on the American Oldsmobile in 1940. This was a genuine two-pedal system, with no clutch at all, and in various forms was adopted on nearly all American cars after the war. Today all American cars have automatic transmissions as optional extras, and on the more expensive models they are standardised. The same applies to the Rolls-Royce, which in fact uses a modified form of the Hydramatic system. During the 1960s automatic gear-boxes became available on smaller European cars but they inevitably absorb more power than ordinary gear-boxes, so are less suitable to small-engined cars.

The arrangement and location of the gear-box.



ISETTA BUBBLECAR



An example of the ultra-light car, the bubblecar, which was in the same spirit as the earlier cyclecars.

PEUGEOT 204



FIAT 126



Two very popular saloon cars with engines under 1300cc.

Cars of Today

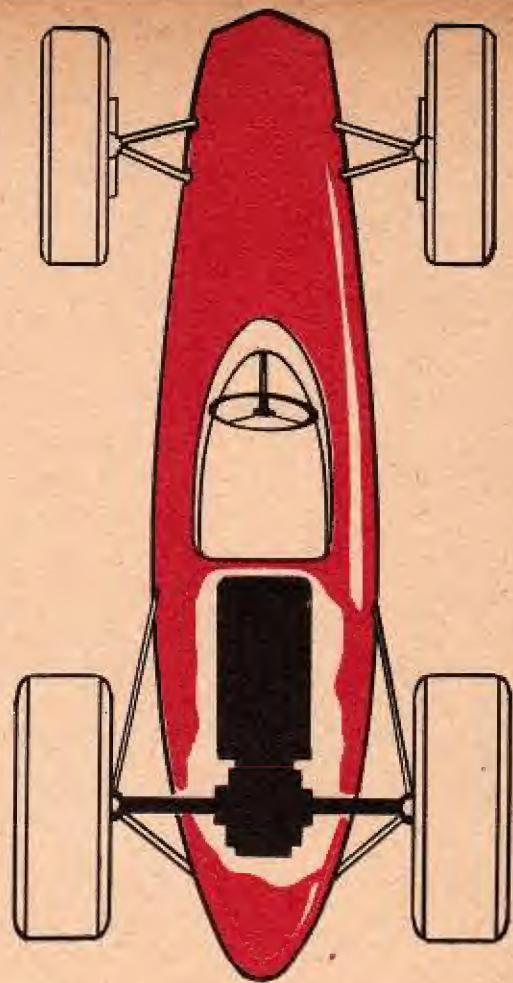
During the 1950s there was a vogue for ultra-light cars in the same spirit as the old cyclecars. Many of these had three wheels, and some had Plexiglas canopies in place of roofs, earning them the name 'bubblecar'. Like the cyclecar they were stepping stones from the motorcycle to the car proper, and as prosperity grew in western Europe the market for such machines dwindled. A young man buying his first car preferred a second-hand Mini or Ford Popular to a new bubblecar, for the former was more spacious, comfortable and reliable. Those were the days of plentiful and comparatively cheap petrol, but even now there does not seem to be any revival of interest in

Why have mini-cars disappeared?

the ultra-light car with one or two cylinders and only two seats. The smallest cars made in Europe are the Italian Fiat 126 and Austrian Steyr-Fiat 126, both of which have rear-mounted two-cylinder engines, full four-seater saloon bodies, and a top speed of over 60mph. Above these come a very popular size of car, with four-cylinder engines of between 800 and 950cc, and speeds of up to 80mph; among these are the Mini, Renault 5 and Fiat 127. The best-selling cars are in slightly larger class again, with engines of between 1100 and 1300cc, four- or five-seater bodies and a choice of two or four doors. In this class are Britain's Ford Escort, France's Peugeot 204, Germany's Opel Kadett and Italy's Fiat 128.

Diagram of the engine arrangement in a mid-engined car.

We have seen that rear-engined cars are on the way out. This layout was never suitable for fast cars anyway, but an alternative which has become widely used in high-performance vehicles is the mid-engined layout, in which the engine is behind the driver but ahead of the rear axle. As the engine's weight is not at the extreme rear of the car it does not swing it out when cornering, but it is close to the driving axle, so avoiding a long transmission shaft from a front-mounted engine. This arrangement was first seen on Cooper racing cars in the 1950s, and soon spread to



Examples of luxury sports cars of today.



LAMBORGHINI



LOTUS EUROPA



FERRARI

all racing cars. Mid-engined Ferrari and Maserati sports/racing cars appeared in 1958 and 1961 respectively, and today all the fastest road-going sports cars are mid-engined. These include very expensive machinery such as the Ferrari Berlinetta Boxer and Lamborghini Countach, both of which cost over £16,000 and have speeds of 190mph, but there are also mid-engined cars of more modest price, such as the Lotus Europa and Fiat XI/9. All these cars are two-seaters, for the chief drawback of the mid-engined layout is that there is not room within the wheel-base for four seats as well as the engine. If the engine were mounted transversely, as it was on the Lamborghini Miura, it might be possible to have two rows of seats, but so far no designer has attempted it.

One of the sadder aspects of the world of motoring in recent years has been the disappearance of

Why are there fewer makes of car today than before?

once well-known makes of car, and the general shrinkage of variety of makes. In 1922, America had nearly 200 different makes of passenger car, but by 1939 the figure had shrunk to 17, while today there are only four major groups, selling 15 brand names between them. There are several reasons for this decline; as mass-production got going, it became more and more difficult for a car manufacturer to make a profit unless he also went in for large-scale production. In the early 1920s a few thousand units per year might be a viable figure even in America, but by 1930 anything less than 20,000 was dangerous ground, and 10 years later the figure was nearer 40,000. This did not apply so much to makers of sports and luxury cars, which is why more makes survived in Europe, but other factors were at work too. At the beginning of the motor age almost every country tried its hand at car-making, but gradually smaller countries like Belgium and Switzerland found that it was easier to import, or to assemble, foreign cars than to make their own designs for a limited market. Belgium had more than 15 makes in 1920, and only one by 1939, although there were plenty of Fords, Chevrolets and Citroëns being assembled in the country.

Another trend which has killed off a number of makes in recent years is the merging of several companies. Riley became part of the Nuffield Group in 1938, which in its turn became part of the British Motor Corporation in 1952

HISPANO-SUIZA



Trojan



NAPIER



A selection of the badges of cars which have now gone out of production due to the standardization involved in mass-production techniques.

and then British Leyland in 1968. From being a highly respected individual sporting make, Riley became increasingly like Morris, Austin or Wolseley, and the final model, the Elf of 1962, was little more than a Mini with a different radiator grille. This practice has become known as 'badge engineering', for the only significant difference between makes lies in the badge. British Leyland decided that the prestige of Riley was not even worth the different grille, and in 1969 they dropped the Riley name. Other makes have disappeared because of national financial troubles, such as those which hit Aston

Martin towards the end of 1974. However, Britain still has more makes than any other country, thanks to the efforts of enthusiasts who build individual cars in small numbers. An interesting example of this is the Panther company of Weybridge, Surrey, who make cars of pre-war appearance, but using the latest materials and powered by Jaguar six- or twelve-cylinder engines. One is an open two-seater sports car known as the J-72, and another is a luxury saloon looking rather like a 1930 Bugatti, called the De Ville. This has a TV set for the rear-seat passengers, and costs nearly £22,000.

WOLSELEY



PANTHER REPLICA



How Cars Work

Both petrol- and steam-engines de-

What is the internal-combustion engine?

pend on the same basic principle: that when a gas expands rapidly, either through heating or explosion, it exerts a great pressure which can be used to drive a piston down. The essential difference between the two engines is that in the steam-engine the gas (steam) is heated *outside* the cylinder where the work is being done, and is admitted 'ready made' to

the cylinder, whereas in the petrol-engine the explosion takes place *inside* the cylinder, hence the name internal combustion.

To produce an explosion in the cyl-

What essentials are needed for an internal-combustion engine to work?

inder two essentials are needed: a gas which can be ignited easily, and a spark or flame to ignite it. (Not all engines need

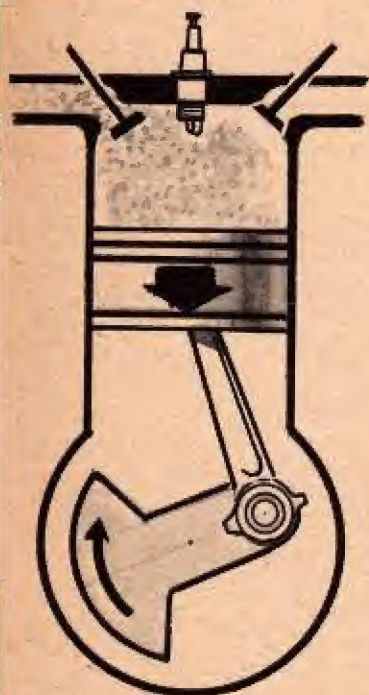
a spark; in the compression-ignition engine, commonly called a Diesel, the pressure of the gas is sufficient to cause an explosion.) In some very early internal-combustion engines ordinary coal gas was used, but all modern engines use a mixture of air and petrol. This is mixed in a device known as a carburetter. Early ones were known as surface carburetters. In these, air was drawn across the surface of the petrol in the fuel tank, or sometimes bubbled through the liquid. This was dangerous, because if the ignited mixture was blown back the carburetter caught fire.

As there might be several gallons in it, the whole car would be ablaze in a moment. Also, the petrol splashed about and spilt if the car jerked or went down a steep hill. So the surface carburetter was replaced by improved types in which the fuel tank was quite separate from the mixing device. Modern carburetters use various forms of spray. One or more jets send a fine spray of petrol into the mixing chamber where it meets air drawn from outside. Often an air filter is provided to stop dirt from entering the carburetter and clogging it.

Diagram to show how the four-stroke internal-combustion engine works.

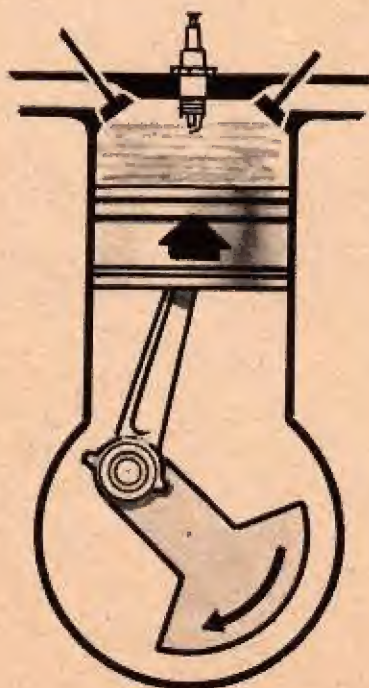
INDUCTION STROKE

Inlet valve open allowing air-fuel mixture into cylinder.



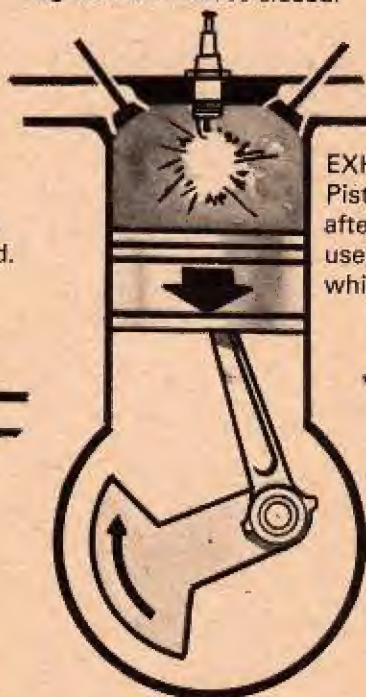
COMPRESSION STROKE

Mixture being compressed. Both valves closed.



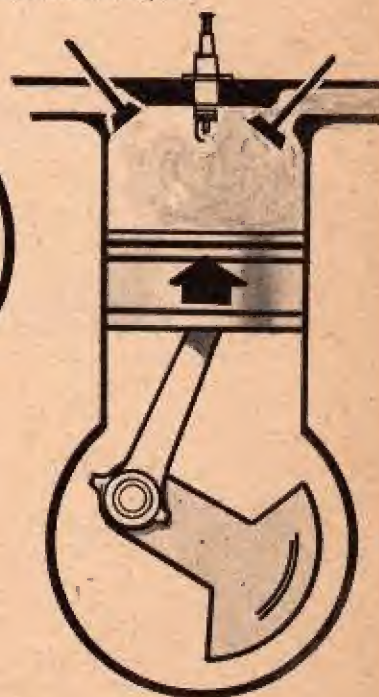
IGNITION STROKE OR POWER STROKE

Spark plug producing spark ignites mixture, so forcing piston down and producing the driving force to run engine. Both valves closed.



EXHAUST STROKE

Piston rises to top of cylinder after power stroke, so dispelling used gases etc. via exhaust outlet which is now open.



The mixture is admitted to the cylinder by a valve, known as the inlet valve, and compressed by the upcoming piston. The next step is to cause an explosion. This is done by a spark provided by a battery and coil, which feed electricity to a sparking plug mounted in the cylinder head. In some very early cars ignition was by a platinum tube placed on top of the cylinder, and ignited to white heat by a small petrol-fired burner. This crude system was soon replaced by electric ignition, and indeed some of the earliest cars, including the Benz, used electric ignition from the start.

Once the mixture is ignited, the force of the explosion pushes the piston down, and

when it returns it forces the burnt gases out of the cylinder through the exhaust valve. The complete cycle of operations has four stages, hence its name four-cycle, or four-stroke engine. To recap, the stages are as follows:

- (1) **Induction:** the mixture is drawn into the cylinder by the descending piston.
- (2) **Compression:** the piston rises and compresses the mixture into a very small space.
- (3) **Explosion (Power Stroke):** the mixture is ignited by the spark, and expands very quickly, forcing the piston down.
- (4) **Exhaust:** the piston rises again, driving the burnt gas out through the exhaust valve, and thence through the exhaust pipe to the open air.

Note: we have talked about the piston rising and falling because most car engines are mounted vertically. However, there are some, such as the Volkswagen 'Beetle', in which the cylinders lie horizontally. The principle of opera-



Cylinders arranged in a V-formation in a six-cylinder engine.

tion is exactly the same.

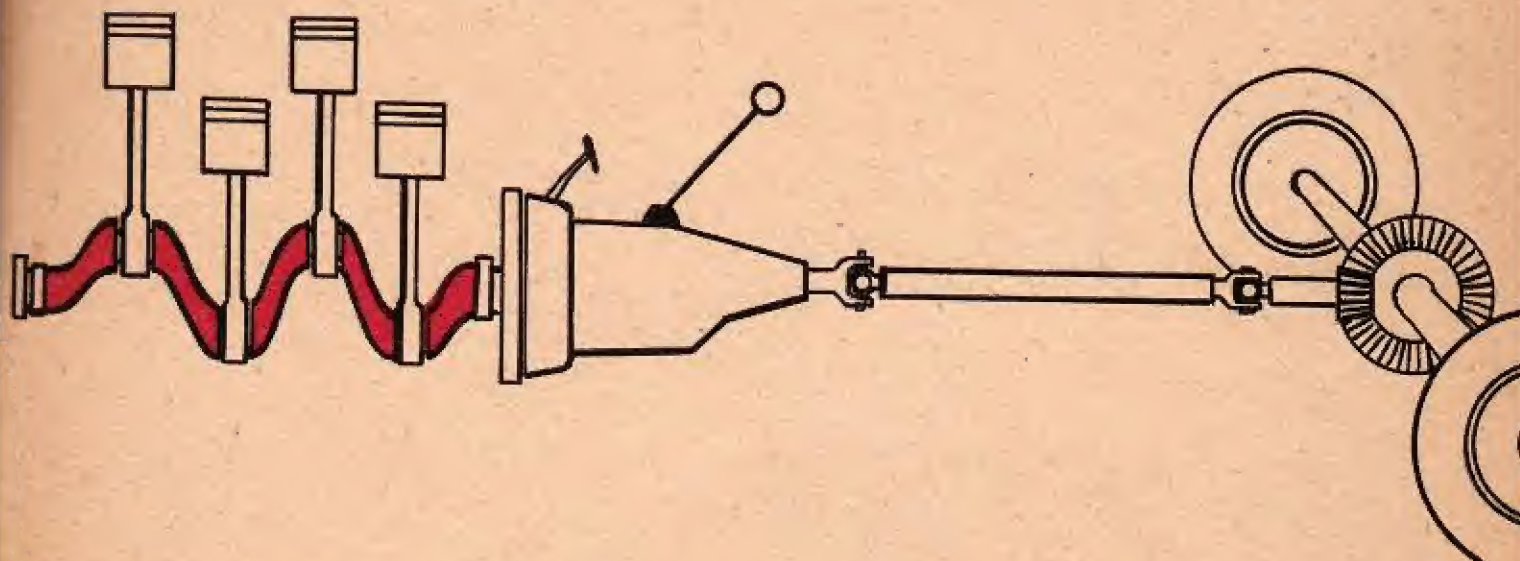
Early engines had only one cylinder, but these ran roughly, for there was only one power stroke for each turn of the engine, and two- and four-cylinder engines were soon introduced, although singles were used for very small cars and motor-cycles, and are still seen today on light two-wheelers. The first six-cylinder engine came in 1903, and, later, eights, twelves and even sixteens were made, some of the eights and all twelves and sixteens having the cylinders in V-formation to avoid too long an engine. Today most small family cars have four-cylinder engines, with in-line, or occasionally V-6s, for the medium-sized cars, and V-8s for large cars such as Rolls-Royce and most American cars. There are a few V-12s such as the British Jaguar and Daimler, and the Italian Ferrari and Lamborghini.

We have seen how the pistons move up and down in the cylinder, but this motion has to be turned into a rotary one, so that the engine can drive a revolving shaft leading to the rear wheels. The pistons are linked by connecting rods to a very strong shaft

What is a crankshaft?

known as the crankshaft. This is built in such a way that the vertical motion of each rod is converted to rotary motion, turning the whole crankshaft (see diagram).

The position of the crankshaft in relation to the rest of the car.

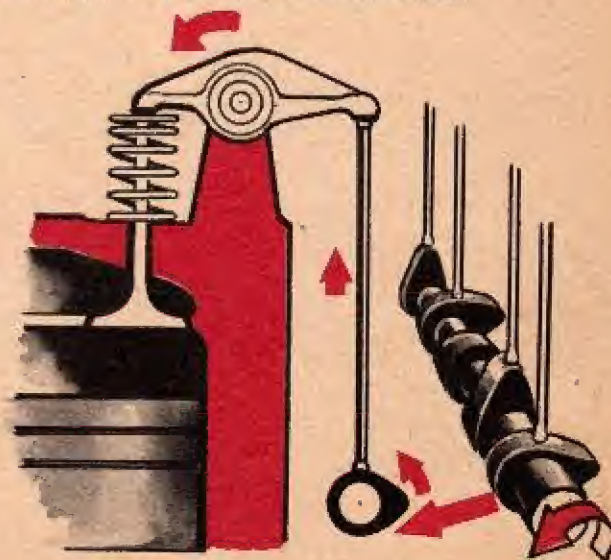
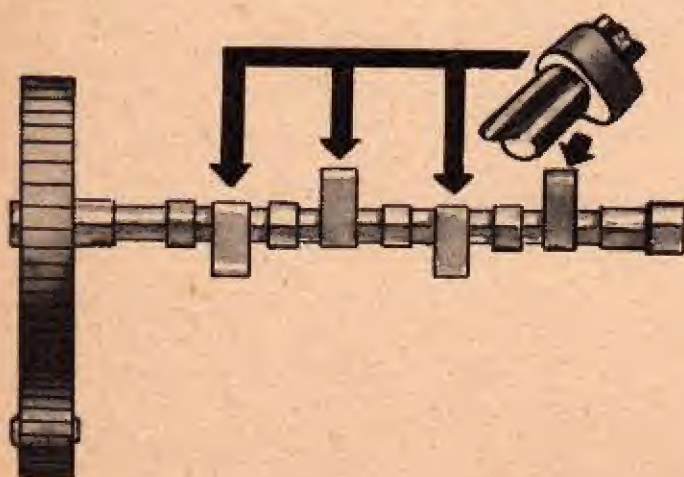


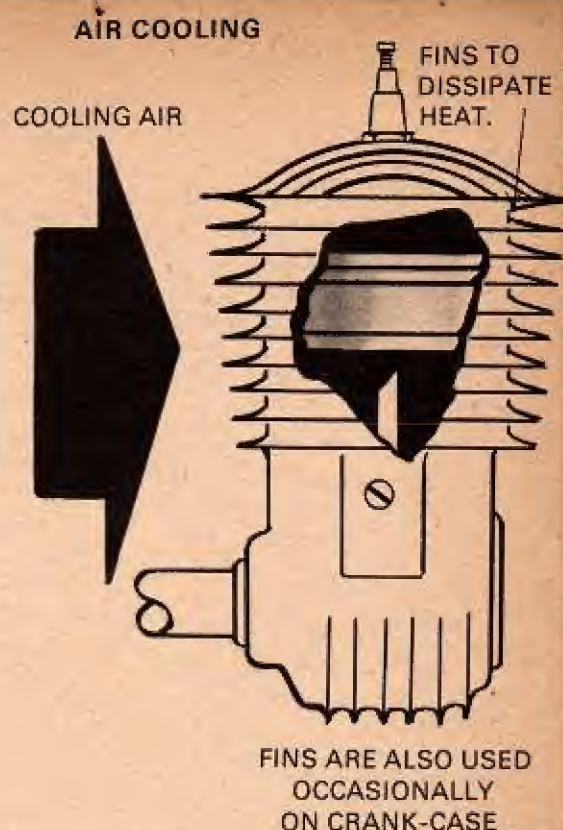
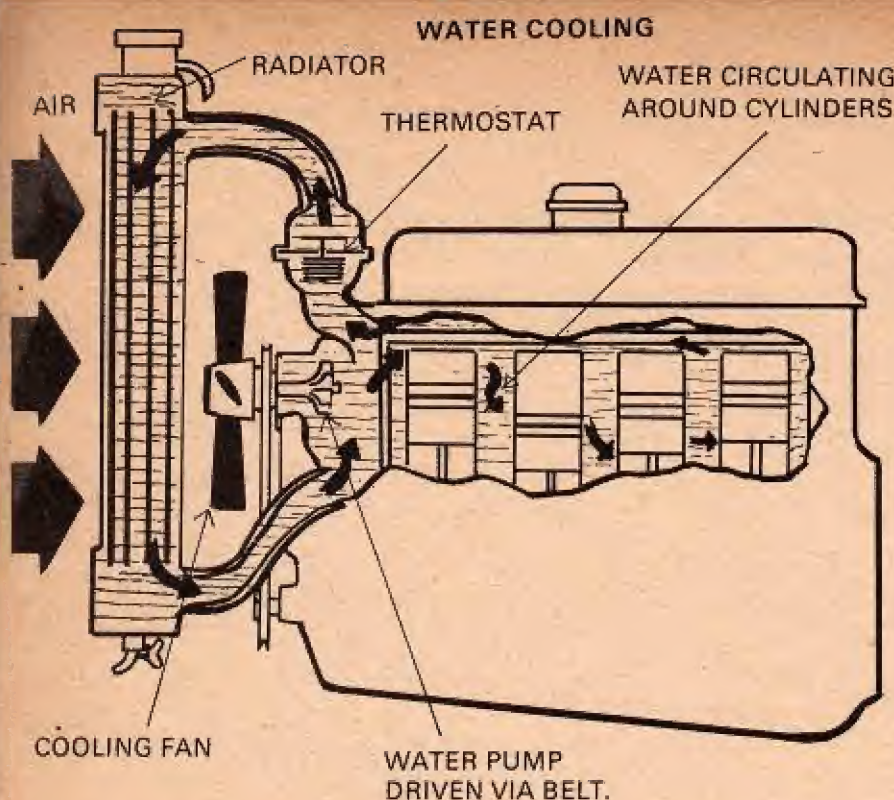
Obviously it is very important for the efficient running of the engine that the valves should open and close at the correct times. This is controlled by the camshaft which is a straight rod with small raised 'bumps' or cams at intervals along it. As the shaft turns they push the valves open against the action of a spring. When the cam drops,

What is a camshaft?

the spring automatically closes the valve. The timing of a camshaft is a very important part of keeping the engine running well. The camshaft is driven from the crankshaft either by a chain or a train of gears.

Diagram of the camshaft in relation to the rest of the car.





Air and water cooling systems.

There are two other essential aspects of a petrol engine: cooling and lubrication.

Why do cars need radiators and oil?

The explosions in the cylinders generate great heat which has to be dissipated by blowing air over the cylinders, or, more usually, by passing water through specially designed passages around the cylinders. The water would quickly boil unless it were cooled, so it is passed through a series of honeycomb-shaped tubes known as the radiator. This is mounted at the front of the car, where the cooling air rushes through it. Sometimes, in very hot weather, or when the engine is working hard as in climbing mountain roads, the air does not cool the water sufficiently. It then boils, and the driver has to stop until it has cooled down. Early cooling systems were automatic. The water rose naturally to the top of the radiator, and was replaced in the engine by cooler water from the bottom of the radiator. This was called the thermo-syphon system. Modern engines have a pump driven from the crankshaft. Air-cooled engines such as

the Volkswagen's have a fan which directs a flow of air over the cylinders. No radiator is needed, so there is no danger of boiling in summer or freezing in winter.

The second vital point is the lubrication system. There are many moving parts in the engine which would quickly generate great heat and wear each other out if they rubbed together. If, however, a very thin layer of oil separates them, the heat generated is much less. The layer need only be .001 inches thick, but it must cover the whole surface, and the flow must be kept going at all times. On all modern engines the oil is pumped under pressure to the crankshaft bearings and other vital places. The oil is kept in the sump at the bottom of the engine. It is used over and over again, but must be replaced occasionally, as it becomes mixed with carbon, dirt and other impurities.

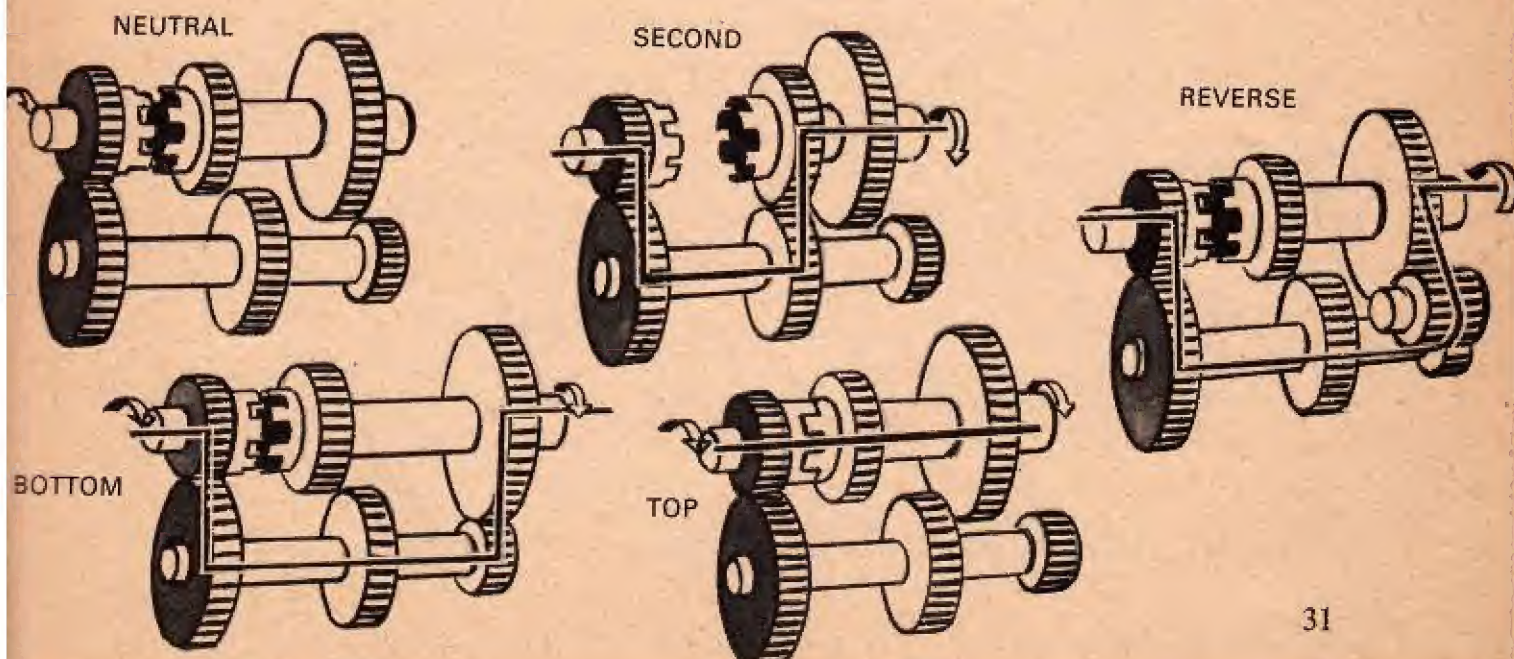
Unlike the steam-engine which works

Why do cars have gear-boxes?

with the same efficiency at any speed, the internal-combustion engine works at its best when turning quickly. However, it has to move the car at a variety of speeds from a few miles an hour, when starting or reversing, up to 150mph or more in the case of a fast sports car. Some system has to be found to vary the ratio between the engine speed and that of the wheels which actually move the car, so that, when starting, the engine can turn fairly fast although the road speed is very slow. This is done by a gear-box in which gear-wheels on a main shaft driven from the engine mesh with other gear-wheels of different sizes to give the different ratios. Most small-engined cars have four forward ratios, while larger engines can make do with three. A large engine is said to be more 'flexible', meaning that it works well at a variety of speeds, so gear changing is less necessary than with a smaller unit. The gears cannot be changed while the main shaft is being driven from the engine, so there is a series of plates called a clutch which disengages the drive from the engine while the changes are being made.

The sliding pinion gear-box, as the conventional system is called, was invented by Emile Levassor of the Panhard et Levassor company in 1891. Even then he was not particularly satisfied with it, saying "C'est brutal, mais ça marche" (It's crude, but it works). Ever since Levassor's day people have been trying to find an alternative to the gear-box. An ingenious system used on many of the cyclecars was known as friction drive. This consisted of two discs in contact at right angles, one being driven from the engine, the other driving the wheels via chains or a shaft. If the edge of the latter was slid across the face of the former, the gear ratio varied, with top speed being obtained when the second disc was nearest the edge of the first. The system worked well so long as the cork surface did not develop flat spots, but it was only suitable for transmitting fairly low power, and could never be used on large cars. Its heyday was from 1905 to the early 1920s.

How the gear-box operates. Most small engined cars have four forward gears and one reverse, but larger engined cars can make do with three forward gears and one reverse since larger engines work better at a greater variety of speeds making gear changing less necessary.





The first motor-race, the Paris-Rouen Trial, 1894. The contest attracted 22 entries including a steam-bus and was more a demonstration of new vehicles than an actual race.

Motor Sport

As soon as a few cars had been made their builders naturally wanted to test them against each other. There was an unofficial race between two steam carriages in America in 1878, but the first official motor contest was the Paris-Rouen Trial of 1894. This attracted 22 entries, including a steam-bus. It was not strictly a race, as the prize did not go to the fastest car, but was more in the nature of a demonstration of the new vehicles. The first proper motor-race was held in 1895, when competitors had to drive from Paris to Bordeaux and back, a distance of 732 miles. Again 22 competitors started, 15 with petrol-engines, six steamers and one electric-car. The winner was Emile Levassor whose Pan-

When were the first motor-races held?

hard averaged 15mph. After this the Automobile Club de France organized a major race each year, always increasing the distance covered, culminating in the Paris-Madrid Race of 1903. A total of 179 cars and 59 motorcycles started in this event, but so many drivers and spectators were killed that the race was stopped at Bordeaux, and the cars were not even allowed to return home under their own power. They had to be towed by horses to the railway station and put on a train for Paris. In 1902 an important event took place in Belgium, where the first circuit race was held; competitors had to cover six laps of 53 miles each, thus setting a pattern for all subsequent motor-races. After Paris-Madrid, no more town-to-town races were held.



Apart from the A.C.F.'s town-to-town races, the most important events were the Gordon

What was the Grand Prix? Bennett Races, in which teams of three cars from each country took part. As more and more car makers wanted to take part in racing the restriction of three cars per country grew more annoying, so in 1906 the A.C.F. organized a new event, open to as many competitors as wished to take part, so long as the cars conformed to a maximum weight limit of 1,000kgs. This event was called the Grand Prix (Big Prize), the first of thousands of races to bear this name. Because France had the earliest motor industry, most of the important early races were also held there, and until 1921 there were no other Grands Prix, though there was an American Grand Prize. In 1921 Italy organized a Grand Prix, and in

The first Grand Prix, 1906. Before 1921, these competitions were all held in France. Now they take place all over the world.

1925 Belgium followed suit, so from then on the French event had to be called the French Grand Prix to distinguish it from the others. Now there are about 14 Grands Prix held each year, all over the world, these being the venues for the World Driver's Championship, the most important prize in motor-racing.

What was Brooklands track? In the early days of the sport Britain lagged behind the continental countries in motor-racing, one of the reasons being the 20mph speed limit on all roads, which no local authority would alter, even for one afternoon's racing. When Britain



A Formula One race. In these races there is a limit set on the engine capacity of the cars that enter. Since 1965, the limit has been 3 litres.

had to organize the 1903 Gordon Bennett Race, a privilege resulting from her victory in the 1902 event, the race had to take place in Ireland. One man who was saddened by this state of affairs was H. F. Locke King, a Surrey landowner who had a large estate at Weybridge. He not only wanted to see motor-racing in Britain, but also realised the need for a track where cars could be tested at speeds higher than 20mph! So, at his own expense (over £150,000) and on his own land, he built a concrete-banked track with a lap distance of $3\frac{3}{4}$ miles. It was opened in the summer of 1907, and soon attracted car enthusiasts from all over England, and from abroad also, for there was nothing like it in Europe. Although the French had straight roads and no speed limits, they could not rival the smooth surface of Brooklands, and because it was a circular track it could be used for tests (and, later, races) of up to 24 hours. In fact, before racing ever started, S. F. Edge drove a Napier for 24 hours on the track, at an average speed of nearly 66mph. Innumerable

races, long and short, were held at Brooklands, from 1907 to 1939, with only an interval of 6 years caused by the First World War. Alas, its use as an aircraft factory during the Second World War damaged it so much that it was never reopened for racing, although the remains of the track can still be seen from the railway between Weybridge and West Byfleet. Other countries imitated Brooklands, America with the Indianapolis track opened in 1909, and France with Montlhéry, near Paris, opened in 1924.

Between the wars motor-racing expanded greatly in variety and popularity, but the

What is Formula One racing?

most important events were always the Grands Prix, which attracted the top drivers and the fastest cars. The first Grand Prix had imposed a weight limit of 1,000kgs, and since then there have nearly always been regulations of some kind concerning the cars which take part in these races. For safety reasons the regulations have usually been de-

signed to prevent the cars from being too fast, but as the organisers reduced the size of the engines, so designers made them more efficient, with the result that speeds did not decline for long. From 1919 to 1921 engine capacity was limited to 3 litres, from 1922 to 1925 to 2 litres, and from 1926 to 1927 to 1½ litres, yet a 1926 1½-litre Talbot was faster than a 3-litre Fiat of six years earlier. After World War II smaller classes of racing became popular, so the Grand Prix cars became known as Formula One cars, and this name has tended to replace the older term in recent years. Today's Formula One has been in existence since 1965, and restricts engine capacity to 3 litres. In 1957 the first Formula One cars appeared with the engine behind the driver, and by 1961 a complete revolution had taken place, with no front-engined cars being seen on the Grand Prix circuits.

Grand Prix racing has always been an expensive business, available only to manufacturers and to the very richest private entrants. Today most manufacturers have to rely on sponsorship from non-motoring sources such as cigarette or perfumery firms. Cheaper forms of racing have nearly always meant smaller cars, from the single-cylinder *voiturettes* (light cars) of pre-1914 days to today's Formula Ford and Formula Vee cars. One of the most significant forms of cheaper racing appeared just after World War II, when some British enthusiasts built very light machines, mostly powered by single-cylinder motor-cycle engines, restricted to 500cc capacity. The Cooper was the best-known and most successful, and set the fashion for mounting the engine

Are there cheaper forms of racing?

behind the driver, which later spread to bigger cars. In 1950, 500cc racing was officially recognised by the F.I.A. (Fédération Internationale de l'Automobile), and given the name Formula Three. Among drivers who began on Formula Three cars and later became world famous were Stirling Moss and Jack Brabham. Since the 1950s there have been several changes in Formula Three regulations, and today's cars are larger and more expensive than the Cooper 500s. For less well-off enthusiasts there are Formula Ford and Formula Vee, the former for cars powered by 1600cc Ford engines and the latter for Volkswagen engines of 1300cc or 1600cc (Super Vees). Even cheaper than these are the Formula 750 cars, originally intended for Austin Seven engines, but now mainly using Reliant units of 750cc. Most of these cars are home-built, and can cost as little as £500, but exciting racing can be had with them.

Besides circuit racing there are many forms of motorsport held on rough surfaces or grassy fields. Among these are trials, autocross and rallycross. In trials, cars climb a very steep and often muddy hill one at a time, whereas in autocross they race two at a time over a circuit which may include grass and loose gravel. Beginning in the 1950s as an 'unofficial sport', autocross is now recognised by the Royal Automobile Club and has its National Championship. Over 30 meetings are held each week-end in Britain, attracting crowds of several thousand to the bigger ones. Autocross cars vary from ordinary saloons like the Ford Escort to specially designed machines with four-wheel-drive and four-wheel-steering which are useless for anything but autocross. One, Tony Fisher's Bufi-Mowog, had two

What is autocross?

engines, a Mini Cooper at the front driving the front wheels, and an 1100 at the rear for the rear wheels.

A variation on autocross is rallycross in which four cars compete at a time. This was introduced for a T.V. programme when the 1967 R.A.C. Rally was cancelled because of foot-and-mouth disease, and was so popular with viewers that it was made a regular part of the motor-sport calendar, though always with T.V. in mind. The cars are more conventional than in autocross, and well-known racing circuits such as Lydden Hill and Croft are used.

The essential difference between rallying and racing is that the former is held on public roads with only short sections (called 'special stages') on which out-and-out speed trials are held. Nevertheless it is on these that the overall winner is decided. The first rallies, although the word was not used then, were touring demonstrations of the motor-car, such as Britain's Thousand Miles Trial of 1900, in which the cars visited the main towns of Britain, as much as anything to demonstrate the new inventions to people who might otherwise have little

When did rallies begin?

Autocross. In autocross, cars race two at a time over a circuit which may include grass and loose gravel.





A motor rally. Rallies are held on public roads with only short sections on which out-and-out speed trials are held. It is on these, however, that the overall winner is decided.

chance of seeing a motor-car. The first competitive road event was the Herkomer Trial, held in Germany from 1905 to 1907, which consisted of a road section of about 500 miles, a speed hill-climb, and a level sprint at the finish. As well as the trophy, the winner had the privilege of having his portrait painted by the organiser of the trial, Sir Hubert von Herkomer, who was a well-known artist! The Prince Henry Trials of 1908 to 1911 were organised by Prince Henry of Prussia, younger brother of the German Kaiser, and attracted some very sporting cars such as the Vauxhalls and Austro-Daimlers described on page 14. The first actual use of the word 'rally' came in 1911 when the first of the famous Monte

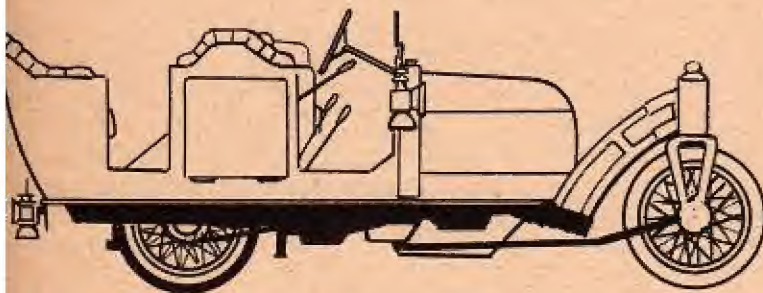
Carlo Rallies was held. It attracted only 23 cars, but by the 1930s the entry list ran to 300, and there were starting points from such distant cities as Glasgow, Lisbon and Athens. At this time the 'Monte' and other rallies were decided on the road section, but increasing restrictions have led to the greater use of special stages, usually on private land such as forests, and the road sections have become merely touring intervals between special stages. Once synonymous with the word rally, the 'Monte' has become less important in recent years, giving place to such events as the R.A.C. Rally, Swedish Rally and Finnish Rally of a Thousand Lakes.

Car Oddities

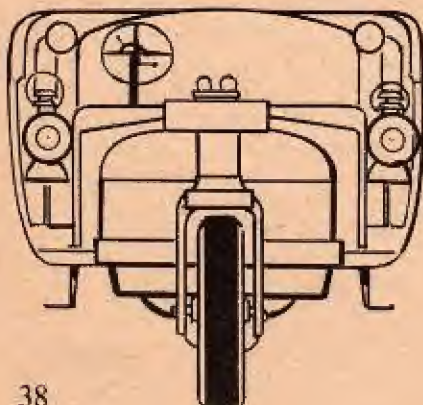
The great majority of cars have had three or four wheels, but from time to time inventors have tried to make a cross between car and motor-cycle, in the form of a two-wheeled car. The most ambitious of these was the work of a Russian, Count Peter Schilowsky, who designed a two-wheeled car for the Wolseley company to build, in 1912.

It was powered by an ordinary engine, and to keep it balanced when stationary there was a gyroscope driven by the engine, which absorbed only 1.25hp, the rest of the power going to the rear wheel. When the engine was running the gyrocar could stand perfectly stationary, and one could even stand on the side of the car or step into it without disturbing the balance. When the engine was switched off the gyroscope ceased to rotate, so small auxiliary wheels, like the stabilisers on a child's bicycle, were lowered. Schilowsky's gyrocar was a large machine, seating six people, but its inventor claimed that it needed much less power than a four-wheeler of equal size. There were other two-wheeled cars made, but they were less complicated, relying on their forward speed to keep them upright. None was really successful commercially, as they were always more expensive than a motor-cycle, and hardly any more comfortable.

Schilowsky's car was the most ambitious attempt at making a cross between a car and a motor-cycle—a two-wheeler car. It was built by the Wolseley company in 1912.



SCHILOWSKY'S CAR



Aeroplanes were developed at about the same time as motor-cars, and sometimes the same engineers

Why was the propeller-driven car not a success?

were interested in both forms of transport, so it is hardly surprising that the idea of a car driven by an aircraft propeller was brought up. It sounded attractive, for it would do away with all the complications of gear-box, propeller shaft and powered rear axle. Several types were built in the 1920s, chiefly in France. The Leyat was open, the Traction Aérienne was closed, and both seated two passengers in tandem, as in a light aeroplane. Power came from an air-cooled engine driving a four-bladed propeller, from which the public was protected by wire-mesh and a metal hoop around the circumference. Unfortunately several shortcomings appeared when the cars were tested; the noise



The Leyat was an attempt to combine developments in the aeroplane with those in the car. It was a car driven by an aircraft propeller and was built in France in the 1920s. Unfortunately it had many shortcomings so the idea was dropped after a number of years.

level was much higher than on a conventional car, and acceleration was much slower because there was no positive contact between the power unit and the road. This does not matter so much with an aeroplane which has a long runway, but for constant stopping and starting such as a car needs it was a serious drawback. Also the advantage of engine braking enjoyed by all conventional cars was lacking, so the brakes would have had to be that much more powerful. After a few years the airscrew-cars were dropped, and have not been revived since.

Many inventors have dreamt of a car

**Which cars could go
on land and water?**

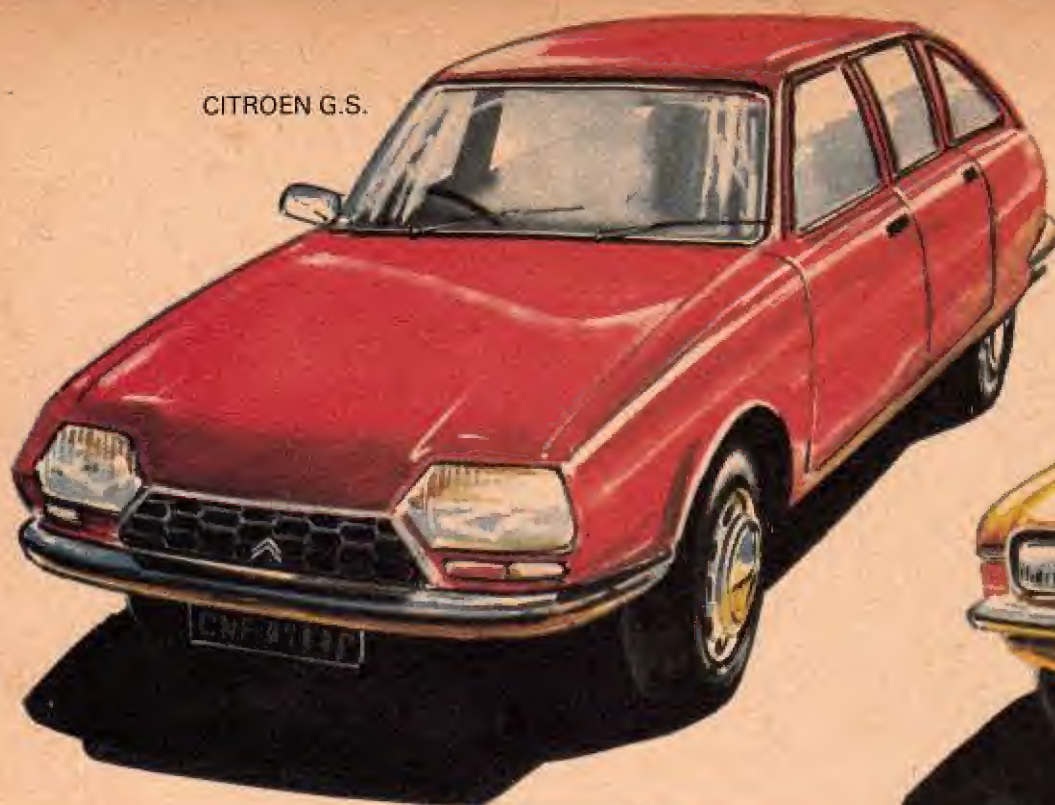
which could travel equally well on land and in water, and at least 20 different designs have actually been built, between

1906 and the present day. They varied in appearance, but most looked rather ungainly on land as they had to have a boat-shaped hull, below which the wheels projected. On land they drove in the normal way, and in water a screw at the rear took over. The amphibious Jeep, and its German equivalent the amphibious Volkswagen, were used in large numbers during World War II, and in 1961 an amphibious car actually went on sale to the public. It was the Amphicar, also German but powered by a British Triumph Herald engine. With a four-seater body, it was capable of 70mph on land and $6\frac{1}{2}$ knots in the water. One crossed the Channel from France to England, but on the whole it was not safe in any but the calmest waters, and production ceased in 1968 after about 3,000 Amphicars had been made.

This amphibious car actually went on sale to the public in 1961. It was a German model but powered by a British Triumph Herald engine. It was capable of doing 70 m.p.h. on land and $6\frac{1}{2}$ knots in water. Because it was only safe in the calmest of waters, however, production was stopped in 1968.



CITROEN G.S.



BRITISH LEYLAND



LANCIA BETA COUPE.



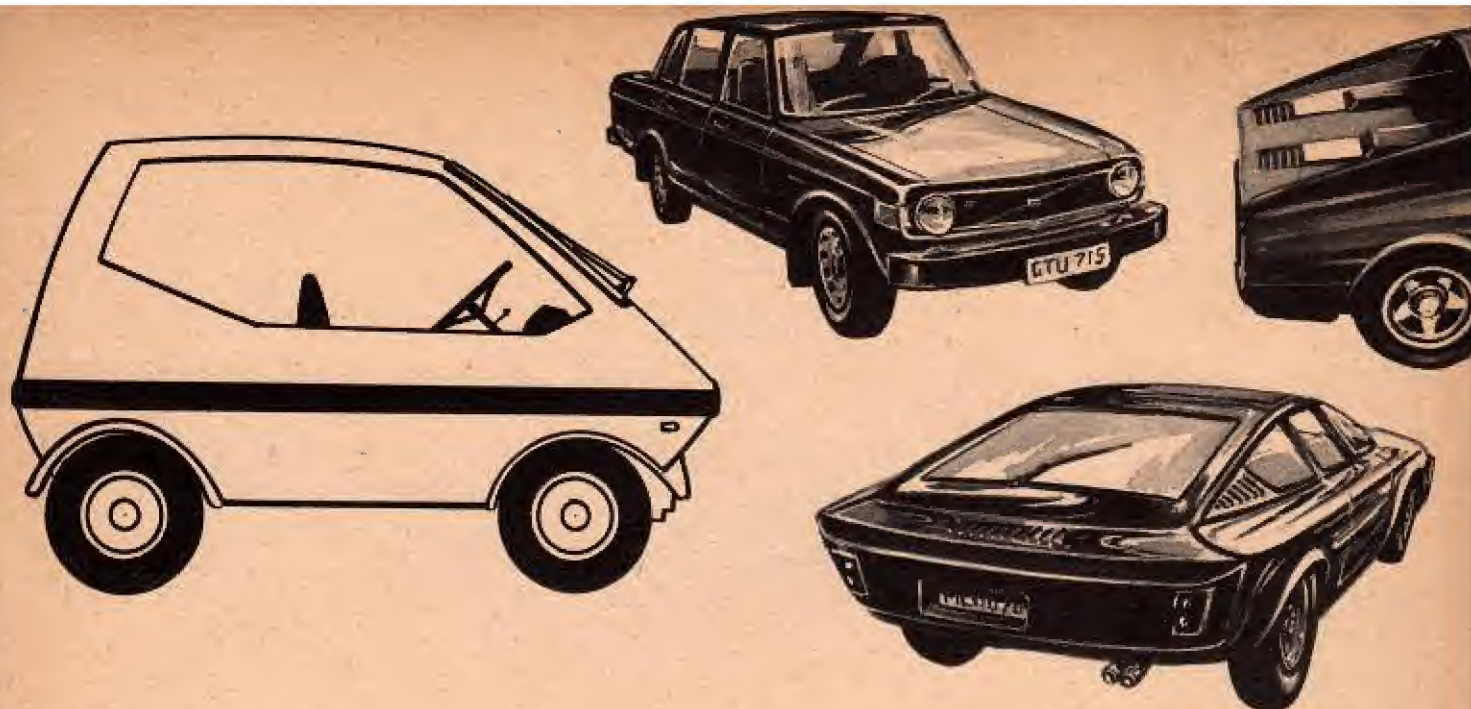
JUSTIN ALLEGRO.



FORD CONSUL GRANADA.



OPEL COMMODORE.



Some experimental cars and cars of the future. The typical car of the immediate future is likely to be a family saloon of between 1 and 2 litres capacity since, as petrol becomes more expensive, economy rather than performance will be the first consideration.

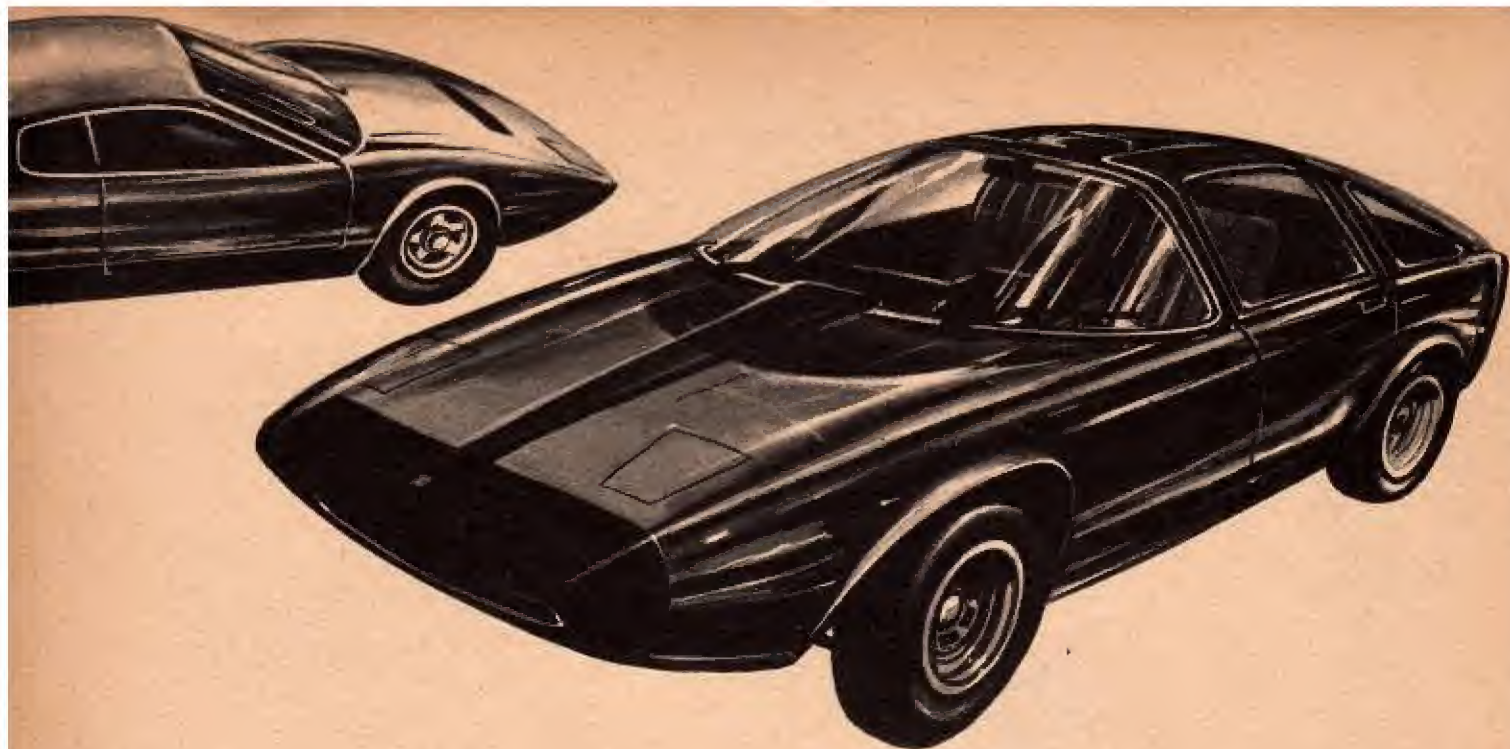
The Future

Until fairly recently, forecasts of the future of car design spoke of ever-increasing speeds, certainly for sports cars, but this is no longer a probability. Almost every country in the world has an overall speed limit now, usually of 80mph and often less, and this, combined with the shortage of petrol which became dramatically evident at the end of 1973, has made the ultra-fast car pointless if not downright anti-social. The fastest cars on the road today are the Ferrari Berlinetta Boxer and the Lamborghini Countach, both Italian and both planned just before the energy crisis hit the Western world. Their maximum speeds are estimated at between 190 and 200mph, but it is almost impossible to find anywhere where these speeds can be achieved. Already both Ferrari and Lamborghini are concentrating on smaller sports cars, and when their two 'super-cars' come to be replaced it is most unlikely that their successors will be as fast or as powerful.

Equally, it is unlikely that the ultra-light mini-car will make an appearance. The typical car of the immediate future is likely to be a family saloon of between one and two litres' capacity, perhaps with a larger body than seems appropriate at the moment, since economy rather than performance will be the overriding consideration. Above this size there will be a dwindling number of high-performance and luxury cars, although there will probably still be a market for a very small number of top-quality cars. It is significant that when Rolls-Royce brought out their Camargue model it was more expensive and luxurious than their other models, not less.

Second only to economy in the car of the future is likely to be safety. Until a few years ago safety was never stressed in advertisements as it seemed to appeal only to the timid buyer, but lately there has been a growing concern

What is an E.S.V.?



in most countries for the safety aspect in car design. Many of the larger companies have built one or more E.S.V.s (Experimental Safety Vehicles) in which a variety of devices are incorporated. E.S.V.s always look heavy at the front owing to their energy-absorbing bumpers; other features include bodies strengthened against crushing, and particularly protection from the engine shooting back into the passenger compartment. Seat-belts are fitted as a matter of course, and experiments have been made with air bags which expand almost instantaneously in front of driver and passenger to protect them from crashing into the windscreen. Unfortunately the rapid increase in pressure caused by the expanding bag may cause ruptured eardrums, and it is unlikely that the air bag will go into regular use. Although companies have spent millions on their E.S.V.s, and have exhibited them at motor-shows, none has gone into production because the expense would make even the smallest two-door saloon cost over £2,000. Nevertheless, ideas from E.S.V.s have been incorporated in production cars, as can be seen in the

energy-absorbing bumpers, capable of withstanding a 5mph crash with no distortion, of the Volvos and most 1975 American cars.

Faced with the shortage of petrol, and also the pollution problems that the internal-combustion engine poses, many inventors have considered a return to the two motive powers popular at the beginning of motoring, steam and electricity.

Will steam- or electric-cars return? No steam-cars have been made for sale for nearly 50 years, but development has been proceeding quietly, and the problem of slow starting has been almost overcome with the latest designs of flash boiler. The American millionaire Bill Lear has spent some \$11 million developing various steam-cars including a four-wheel-drive 800bhp racing car for the 1969 Indianapolis Race, and a pursuit car for the California Highway Patrol. However, the racing car was not ready in time, and the Highway Patrol car proved too expensive to develop to the point where it could be used with confidence.



A car being tested for safety by staging a mock crash and using a dummy in the place of the driver.
A typical car-testing dummy, showing the photographic markings on the head, face and other injury areas.

The electric-car, with its silence and cleanliness, has seemed a very attractive proposition for town work, and a considerable number of experimental models have been made over the past 10 years. A good example is Ford's Comuta which seated two adults and two children within a very short wheel-base; four 12-volt batteries gave it a range of 40 miles at a steady 25mph. When it was announced, in 1967, it was stated that with other, more expensive batteries, more than 40mph and a greatly increased range would be achieved. Unfortunately such batteries would have made the car so expensive that it would have found hardly any buyers. Despite many experiments, a cheap, powerful and long-lived battery has not been found. Thus the owner of an electric-car can have reasonable performance (up to 35mph) over a reason-

able distance (40-50 miles), or improved performance at the expense of a drastically reduced range, and it is this drawback that has prevented public acceptance of the electric passenger car. When they were testing the Comuta, Ford executives found that a sudden burst of acceleration at traffic lights on the way to work might mean that they were stranded on the way home. Another factor against large-scale use of electric-cars is that the thousands of charging stations necessary would increase the country's electricity demands beyond any possibility of meeting them. It all comes back to the basic, inescapable problem: that all motor-vehicles need energy to propel them, and this energy can only come from two minerals of which there is a dwindling supply, coal and oil.



The Law and the Motorist

Motorists have always been subject to laws which, on the whole, they have found irksome. These began, as we have seen, with the Red Flag Act of 1865, and up to the early 1900s laws were mainly concerned with speed limits. By 1903, however, there were enough cars on the road for Parliament to think that further laws were necessary, and these were embodied in a comprehensive Motor-Car Act, which came into force on January 1st, 1904. Among the welcome parts of it was the raising of the speed limit from 12 to 20mph, but other parts included compulsory driving licences and registration numbers for

cars. The latter seems reasonable to us, but was very unpopular with certain people who resented having to carry numbers 'like a common hackney cab'. Also the number plate made it much easier for the police to trace a car which had been seen speeding. Another provision of the 1903 Act fixed a minimum age for driving a car at 17 years, which is still in force today. Before that, some children of 12 or 13 drove themselves to school, if they were lucky enough to be given a car!

Although driving licences were compulsory from 1903, it was not necessary in Eng-

When did driving tests begin?

A car being tested for the M.O.T. This test, first made law in 1960, is a way of ensuring that all cars over three years old are roadworthy. Brakes, lighting, steering, and the condition of the bodywork are all tested.

land to pass any form of test until 1935. Then the Ministry of Transport introduced a test involving reversing, turning in the road and general driving, which was basically the same as that used today. Britain was in fact very late in having a compulsory driving test; in France it was introduced in 1893, when there were only a handful of cars in the country. Early French licences were valid only for the make of car in which you had passed the test. The Hon. C. S. Rolls passed his test in 1898 on a Panhard, and when he bought a Mors three years later he had to pass another test. With growing numbers of makes, this rule was soon abolished. Many countries have more severe driving tests than our own; in Canada, a written examination is required, and in Russia candidates have to show some knowledge of repairs and how a car works.

For a long time the police have had the power to examine a car for its condition, and to prosecute if it is seriously unroadworthy, but it was not until 1960 that a law was introduced in Britain requiring all cars over 10 years old to undergo a compulsory test. The main points tested were brakes, lighting, steering and the condition of the bodywork. The tests were carried out by order of the Ministry of Transport (hence the name M.O.T. test), but could be performed by any garage licensed for testing. The law is still in force, and the age limit has now been reduced to three years.

What is the 'M.O.T.' test?



GLOSSARY

belt drive: a system of driving the rear wheels by leather belts instead of by a propeller shaft to the rear axle.

chain drive: similar to belt drive, but using chains, either a single one to the centre of the rear axle in light cars, or two to the wheels in heavier cars and commercial vehicles.

cc: cubic centimetres, the unit normally used for measuring the volume of cylinders in the engine. The volume of each cylinder is obtained by the formula $\pi r^2 h$, where r is the radius and h the depth, and multiplying this by the number of cylinders gives the total capacity of the engine. Larger engines are usually measured in litres (1 litre = 1,000cc).

hp: horsepower, the unit used for measuring the power output of an engine. In England and America horsepower was calculated on the

cylinder bore (diameter) only, and so did not bear an exact relationship to the size of the engine, even though cars were frequently named after their rated horsepower (Austin Seven, Morris Eight and so on). Today rated horsepower has been abandoned, and the expression bhp (brake horsepower) is used to describe the actual power output of an engine. This does not necessarily have any relation to size; a 3-litre engine as used in a Ford Granada may develop 140bhp, but a Formula One racing car engine of the same capacity may develop 450bhp.

limousine: a closed car with a glass partition between the driver, usually a paid chauffeur, and the passengers.

litre: *see cc.*

mpg: miles per gallon, the measure of fuel consumption of a car. In European countries this is measured in litres per kilometre.

mph: miles per hour, the normal measure of speed of a car. In European countries this is measured in kilometres per hour.

propeller shaft: a revolving shaft which transmits the power from the gearbox to the rear axle.

rpm: revolutions per minute, the measure of speed of the engine. This is not necessarily directly linked with road speed, as an engine may be revving fast, but if the car is in bottom gear the road speed will be slow.

saloon: a closed car for four or more passengers, with two or four doors. Sports saloon is a loose term for a high performance version, usually with only two doors. The American name for saloon is sedan.

tourer: an open car for four or more passengers. Those for two passengers were usually called simply two-seaters.

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